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March 3, 2000 Serial No. 00-060

Ms. Linda R. Dietz
Remedial Project Manager
United States Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Subject:

Preliminary Design Report Metal Bank Superfund Site Ogden Project 87053-0000

Dear Ms. Dietz:

Ogden Environmental and Energy Services Co., Inc. (Ogden) and Hart Crowser (HC) are providing the enclosed Preliminary Design Report. This submission is in accordance with the Administrative Order for Remedial Design and Remedial Action at the Metal Bank Superfund Site on behalf of the following Respondents, hereinafter identified as the "PRP Group Respondents":

Baltimore Gas and Electric Company
Consolidated Edison Company of New York, Inc.
Long Island Lighting Company d/b/a LIPA
Orange and Rockland Utilities
PECO Energy Company
Potomac Electric Power Company
PP & L, Inc.
Public Service Electric and Gas Company
Virginia Power Company

As we discussed today, the response to the USEPA comment letter dated February 22, 2000 will be submitted separately and can be inserted into Appendix 8 at that time. The last project schedule indicated we would have a meeting to discuss the report on March 14, 2000. In our conversation today, you indicated that you would prefer to delay this meeting until you had some additional time to review the report. Please let me know when you would like to schedule this meeting.

Ms. Linda R. Dietz March 3, 2000 Page 2 of 2

Please contact me at (215) 654-1620 or John Dobi at (973) 430-8036 if you have any questions regarding this Preliminary Design Report.

Sincerely,

Ogden Environmental and Energy Services Co., Inc.

Philip H. McQuiston, P.E.

Project Manager

Enclosures

cc:

Steven Straight (PADEP)

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Cottman Avenue PRP Group Respondents

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Preliminary Design Report

Metal Bank NPL Site Philadelphia, Pennsylvania

Prepared for:

Cottman Avenue PRP Group Respondents:
Baltimore Gas and Electric Company
Consolidated Edison Company of New York, Inc.
Long Island Lighting Company d/b/a LIPA
Orange and Rockland Utilities
PECO Energy Company
Potomac Electric Power Company
P P & L, Inc.
Public Service Electric and Gas Company
Virginia Power Company

Prepared by:

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and

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March 6, 2000

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1.0 INTRODUCTION

This Preliminary Design Report has been prepared in accordance with the Administrative Order (the AO), Docket No. III-98-082-DC, issued by the United States Environmental Protection Agency (USEPA) on June 26, 1998, and the Final Remedial Design Work Plan (RDWP) (dated August 16, 1999) for the Metal Bank National Priorities List (NPL) site located in Philadelphia, Pennsylvania. The RDWP for the Metal Bank NPL site was prepared by Ogden Environmental and Energy Services Co., Inc. (Ogden) and Hart Crowser, Inc. (Hart Crowser) under the AO for the Respondents that are members of the Cottman Avenue PRP Group (PRP Group). The Ogden and Hart Crowser team was approved by USEPA on September 22, 1998, to design the remedy selected by USEPA for the Metal Bank NPL site.

The Remedial Design project is being conducted in two phases. The Pre-Design Investigation (PDI) phase was conducted to collect engineering data to support the design of the remedy. The Remedial Design phase includes the efforts necessary to prepare design reports, engineering design drawings, construction specifications, and associated site work plans. This Preliminary Design Report presents the results of the PDI on the Preliminary Design, and was prepared in accordance with the Record of Decision (ROD) for the site (issued by USEPA on December 31, 1997), the AO for the site, and applicable guidance documents and regulations. The Pre-Design Investigation Report (PDI Report) was submitted on January 21, 2000.

As determined during the PDI, some conditions at the site have changed since the Remedial Investigation and supplemental investigations upon which the 1997 ROD was based, and additional site-specific information was necessary to prepare the design. In addition, remedial technologies continue to evolve and change. Therefore, this Preliminary Design Report and its contents have been prepared to address and account for current conditions. The Preliminary Design has also been prepared to meet the goals and objectives of the ROD and to complete the work in the most effective and efficient manner with the minimal amount of disturbance to the environment.

1.1 Preliminary Design Objectives

The objective of the Preliminary Design is to establish and obtain approval of the conceptual approach that will be developed during the remaining phases of the Remedial Design. The objectives of this Preliminary Design Report are:

- To present the design concepts and general objectives to complete the design and the ROD remedy.
- To present the alternatives to the ROD remedy that should be implemented to most effectively meet the ROD objectives.
- To discuss the rationale for the selection of the alternatives.
- To present supporting evidence or documentation that will allow the USEPA to approve the alternatives during the review of the Preliminary Design so the remaining components of design can proceed in accordance with the schedule in the AO.
- To provide the design drawings at the 30-percent design phase.
- To present the basic remediation plan for the site without the supporting details that will be developed later in the design process.
- To provide a basic outline of the specifications that will be developed as the design progresses.

Further details regarding a description of the project and the project objectives are contained in the RI, the FS, the ROD, the AO, the RDWP, and the PDI Report for the site. The Preliminary Design Report was prepared as the first design document and is intended to present the basis for future design work for the project.

1.2 Definition of Terms

Throughout this document, there are names of the parties that will be involved with the construction, which need to be defined for clarity. The term "Contractor" refers to the Contractor that will perform the remedial action construction work and includes any subcontractors, including the independent third-party licensed survey firm. "Owner" refers to the party that is paying for the remedial work and may not necessarily refer to the property owner. The term "Engineer" refers to the engineer or oversight firm that works on behalf of the Owner to ensure the Contractor performs the work in accordance with the design documents. As the contractual relationship for construction has not been determined, these definitions could change in the future.

1.3 Report Organization

Section 2.0 of this report provides a brief discussion of site background and current conditions to provide background for any parties that are not familiar with the project. Section 3.0 discusses the project design elements. Section 4.0 discusses the ROD remedy alternatives considered for the project and the rationale for selection of the alternatives. Section 5.0 discusses the sequence of construction. Section 6.0 discusses the design components including design drawings and the project specifications. Section 7.0 lists references used to prepare this report. This report also includes tables and appendices, which include an outline of specifications, preliminary drawings, and product information.

2.0 SITE BACKGROUND AND CURRENT CONDITIONS

This section provides a discussion of the site location and description, a summary of the site's previous ownership and use, a summary of the previous site investigations, and a description of the current site conditions.

2.1 Site Location and Description

The site is located on the western shore of the Delaware River in a heavily industrialized section of northeastern Philadelphia, Pennsylvania (see Drawing S-1 in Appendix 2). The northern portion of the site is located on relatively unaltered river shore deposits, in comparison to the remainder of the site. The larger southern portion of the site is located on reclaimed riverbed/mudflats and consists of artificial fill and construction debris placed onsite over time. The site is inactive, with foundations of buildings demolished in 1999, and a 6-foothigh fence that restricts access but is in fair to poor condition and does not completely surround the site. The site is bordered by Cottman Avenue and a mudflat on the west, Milnor Street on the north, Hancock Paper Company (a paper recycling company) and Morris Iron & Steel Company (a metal salvage yard) on the east, and the Delaware River on the south. St. Vincent's School is located to the west of the site across Cottman Avenue and currently appears to operate as a day care center. A City of Philadelphia combined sewer outfall that empties into the mudflat area is located at the southern end of Cottman Avenue. A marina is located adjacent to the mudflat farther to the west.

The site consists of three areas of concern: (a) the Courtyard Area, located on the northern portion of the property (see Drawing S-2 in Appendix 2); (b) the Southern Area, a former scrap metal recovery area, located on the southern portion of the property; and (c) the Delaware River Sediments Area (Figure 1).

The Courtyard Area consists of six former building foundations and concrete floor slabs and one existing steel-framed building on approximately 2.5 acres of land located on the northern end of the site near Milnor Street. The basements or belowground portions of the building have been filled with demolition materials, including bricks and block. Three sides of Building 7, the steel framing that supports the roof, and the roof structure remain. The buildings were located around an open area (the Courtyard Area) that provided access to Buildings 2 and 7 for rail cars and trucks. According to the Site Owner, Buildings 2 and 7 were at one time used for electrical transformer recycling activities.

The Southern Area is approximately 9 acres in size. Currently, most of the Southern Area is graded and vegetated primarily with grasses and heavier vegetation along the perimeter. The Southern Area is approximately 10 to 15 feet above the water level in the Delaware River, which is influenced by tidal fluctuations of 6 to 7 feet in the area of the site. The outer slope on the southern and western sides is steep, with large concrete block material apparently placed for erosion control.

The Delaware River Sediments Area, located adjacent to the southern and western boundaries of the property, consists of mudflats and river sediment. The mudflat area to the west of the site is a fairly flat, unvegetated area that is dry at low tide and under as much as 5 to 7 feet of water at high tide. From the combined sewer outfall along the shoreline to the south, the material consists of a coarse gravel and cobble material with debris throughout. Farther from the site, the material consists of a finer sediment. The Delaware River along the southern boundary of the site consists of a gradually sloping river bottom with a gravely and sandy material. The flat surface along the shoreline is also exposed at low tide and under as much as 7 feet of water at high tide.

2.2 Site Ownership Summary

The ownership of the site was traced to the period between 1882 and 1928, when the site was acquired by a power equipment manufacturing company from unknown prior owners in several separate transactions. The power equipment manufacturer retained ownership of the site until 1955, although reports indicate that some portion of the site was owned by a federal agency between 1928 and 1955. In 1955, the site was sold to a new owner who, in turn, sold the property in October 1962 to the predecessor to Metal Bank of America, Inc. Metal Bank of America, Inc. was acquired by The Union Corporation in 1968, at which time Irvin and John Schorsch took ownership and Union Corporation became a lessee of the property. The Schorsch brothers sold the property to the Philadelphia Authority for Industrial Development in 1980, at which time Metal Bank (now U.C.O.-M.B.A. Corporation) became the equitable owner.

2.3 Site History

The available records are unclear as to what, if any, manufacturing or related activities took place on the site prior to 1955, the period when the site was owned by the power equipment manufacturing firm. Similarly, when the property was under new ownership between 1955 and 1962, available records do not specify site use. However, beginning in 1962, with the site purchase by the predecessor to Metal Bank, until 1979, reports indicate that the site was used for the storage and reclamation of various scrap metals. According to a USEPA letter dated July 12, 1979, onsite Metal Bank activities had ceased by that date. However, reports suggest that the site was used as a storage facility for scrap metal until as late as 1984 or 1985. Aerial photographs indicate there was also a large automobile parking area in the Southern Area at one time.

Electrical transformer salvage operations were conducted at the site from at least late 1968 or early 1969 until early 1973. Some of the transformers handled at the site may have contained

PCB-bearing oil, and it is reported that oil from the transformers was drained onto a graded concrete pad that was connected to an underground storage tank (UST). Spills of the oil and an alleged release, or spills and overfills from the UST, may have caused soil and groundwater contamination at the site. Furthermore, as part of the metal recycling activities during the period from 1968 to 1972, copper wire may have been burned at the site to remove insulation in preparation for copper reclamation.

The investigative and enforcement history of the site began in 1972 when reports of oil seeping from the banks of the Delaware River at the Metal Bank site prompted the United States Coast Guard (USCG) to conduct a series of visual inspections of the Metal Bank site and the Delaware River bank. The site has been investigated since that time, and a summary of the previous investigations can be found in the RDWP dated August 16, 1999 and the PDI Report dated January 21, 2000.

2.4 Areas of Concern and Current Site Conditions

Based on the PDI Report findings and previous investigations, there are six areas of concern where PCBs have been identified in several site media that must be addressed by the Remedial Design. These areas of concern include the following:

- The Courtyard Area soils above the ROD action level of 10 ppm for PCBs.
- The Southern Area subsurface soils above the ROD action level of 25 ppm for PCBs.
- The UST in the Southern Area.
- The Southern Area subsurface where LNAPL is present.
- The riprap along the shoreline of the Delaware River and mudflat area.
- The mudflat area and the Delaware River sediments above the ROD action level of 1 ppm for PCBs.

The Courtyard Area soils were previously identified as having PCB concentrations above 10 ppm in two localized areas identified as CY-1 and CY-2 on the drawings in Appendix 2. The Courtyard consisted of an area surrounded by buildings on the west and south, a property line and fence to the north and east, and an entrance way from Cottman Avenue to the southwest. Milnor Street is also located to the north. The buildings were demolished by the site owner in the fall of 1999, and the Courtyard is now surrounded by concrete slabs and foundations to the west and south. The surface of the Courtyard Area is heavily overgrown with brush and trees. The surface consists of the remnants of old deteriorated pavement, gravel, and soil.

The Southern Area subsurface soils were previously identified as having PCB concentrations above 25 ppm in localized areas identified as SA-1, SA-2, SA-3, and SA-4/5 on the drawings in Appendix 2. The largest area of concern in the Southern Area of the site consists of an area of contamination surrounding the existing UST, which is believed to be part of the source of contamination at the site. The UST was covered by 3 to 4 feet of fill, a large concrete pad, and a 6- to 12-inch imported soil cap. The Southern Area consists of an approximately 9-acre flat field. The area is approximately 500 feet wide from northeast to southwest by 800 feet long from northeast to southeast. The northwest side is bordered by the buildings that surrounded the Courtyard. To the northeast, the site is bordered by a chain-link fence. The Southern Area is bordered by the Delaware River to the southeast and the mudflats to the southwest. The area is vegetated with natural grasses and sparse trees. The higher grasses were cut after the PDI field work was completed, apparently by the Site Owner. One area along the mudflats is covered with an elliptical pile of broken concrete 40 feet in width, 100 feet in length, and 8 feet in height. The perimeter of the site on the southwest and southeast sides is vegetated with more dense trees and a steep slope of approximately 10 to 15 feet down to the Delaware River water level. The slope consists of concrete rubble along the mudflats and larger concrete blocks along the Delaware River. The Southern Area was not significantly changed by the PDI activities. The vegetation above the UST area was disturbed, but will revegetate naturally; some shallow ruts were left in the ground surface from necessary equipment traffic during sampling activities conducted in wet conditions over poorly draining areas.

The mudflat area was identified as having a few discrete location with PCB concentrations above 1 ppm. The mudflat area is a flat area approximately 5 to 7 acres in size located adjacent to the site and the Delaware River. At high tide, the area is completely submerged. At low tide, the area is above the Delaware River water level. The area along the Metal Bank shoreline consists of concrete rubble above the water level and riprap, concrete, blocks, bricks, and cobbles mixed with gravels below the water level at high tide. Farther from the site, the area consists of finer grained sediments. It is believed that the combined sewer outfall may have been constructed with a gravel pavement consisting of riprap, cobbles, and blocks for erosion control.

The Delaware River to the south of the site consists of a shoreline similar to the mudflat area, with some larger concrete blocks and then a gradually sloping bottom at approximately a 10-percent slope away from the site. In some areas, the slope is greater, reaching a depth of more than 15 feet below mean sea level within approximately 100 feet of the site. The area down river from the site beyond Saint Vincent's consists of a private boat launch and a public boat launch. Many recreational boats were moored in the Delaware River off the Metal Bank shoreline at the time that the PDI was performed.

3.0 PROJECT DESIGN ELEMENTS

The AO requires the PRP Group who subsequently retained Ogden and Hart Crowser to design the Remedial Action specified in the ROD for the Metal Bank site. Ogden and Hart Crowser conducted the PDI between September 1999 and January 2000 to gather the information necessary to prepare the Preliminary Design. The PDI program activities were implemented to comply with the RDWP. The methodologies used for conducting the PDI are detailed in the RDWP, Volumes I through V, which was finalized on August 16, 1999. The results of the PDI were presented to the USEPA in the PDI Report, Volumes I through III, which was submitted to the USEPA on January 21, 2000. As discussed in Section 2.4, based on the findings of the PDI, there are six areas of concern that must be addressed by the Remedial Design. In order to address these areas of concern, there are many design elements that must be developed to perform the construction work associated with the Remedial Action. This section includes a discussion of the project design elements that will be developed during the design process. In addition, this section of the report presents the general approach to other elements of construction.

Prior to and during the PDI, Ogden and Hart Crowser identified a number of elements or objectives of the ROD remedy that could be performed using a more effective alternative than specified in the ROD. There was also an inconsistency between the ROD and the AO regarding sediment excavation. As a result, the PRP Group and Ogden and Hart Crowser have previously discussed alternatives to the ROD remedy with the USEPA and are more formally presenting those alternatives with this Preliminary Design Report. Section 4.0 was developed to separate the alternatives from the remaining design elements for ease of review. The following is the presentation of the design elements. These design elements have generally been presented in the order in which they are likely to occur during construction.

3.1 Site Survey

Ogden and American Geotech completed the site survey and tied the site topography, property boundaries, buildings, sample locations, monitoring wells, piezometers, and other features into the Pennsylvania State Plane Coordinate System. The elevations at the site are tied into the National Geodetic Vertical Datum (NGVD, 1988). The coordinates of sample locations are reproducible and can be identified and located in the future with coordinates in three dimensions related to this control based on the State Plane Coordinates. The survey provides 1-foot contours of the topography and accurately locates the site features.

American Geotech also provided control for use by Hart Crowser and Aqua Survey to conduct the bathymetric survey of the Delaware River Sediments Area. This control was used to tie the bathymetric survey into the State Plane Coordinate System so future sediment sample locations could also be located based on coordinates in three dimensions. American Geotech assisted with the bathymetric survey in the mudflat area by surveying the accessible areas at low tide. The bathymetric survey provides 1-foot contour intervals.

The survey drawing forms the basis for the engineering design drawings used for this Preliminary Design; it will also be used as the basis for all future design documents. The design of the remedial action will be accurately located based on the coordinates of the sample points that will also be provided as part of the design with Drawings C-38 and C-39, which are included in Appendix 2 of this Preliminary Design Report. Drawing S-3 in Appendix 2 is the survey control drawing, which will provide the survey control to the Contractor.

During Intermediate Design, a specification for the site surveying work required during construction will be developed. The survey specification will identify the method for determining earthwork quantities based on measurements and the volumes calculated by an independent licensed surveyor. The survey section will also require that surveys are performed prior to, during, and after construction and that the excavations are surveyed to verify that excavation to the required limits is achieved and documented. An outline of the

construction specifications sections that will be prepared during Intermediate Design is included in Appendix 1.

3.2 Traffic Control

During the Intermediate Design phase, Ogden will review traffic routes to and from site. The site is located adjacent to a busy side road just off of Route 95. There is limited room for traffic into and out of the site. Based on a preliminary review and the work done during the PDI, Cottman Avenue is not a good access point to the site. The traffic and parking on Cottman Avenue for St. Vincent's and the narrow alley will not provide the appropriate turning radius for truck traffic. In addition, the traffic load during certain times of the day will impede traffic into and out of the site and thereby inconvenience the public.

As Union Corporation/U.C.O.-M.B.A. has demolished the majority of the buildings on the site, a new access road through the Courtyard Area of the site will be a more appropriate location for site access. The entrance location will limit the interference with the traffic on Cottman Avenue and also provide a safe point of access for the site. The new location is shown on drawing C-3 in Appendix 2 and is likely to require demolition of some remaining concrete building foundations. This location will result in less impact on the traffic to and from the adjacent property, St. Vincent's, which currently operates as a day care center. The location of the access also was selected to avoid interference with intersection traffic.

During Intermediate Design, this location will be inspected to confirm it is appropriate and find any major obstructions. The Pennsylvania DOT standards will also be reviewed to ensure that the design is consistent with DOT standards. Any necessary modifications to the entrance will be made. Based on the DOT requirement review, it will be determined if the Contractor will be required to submit to the DOT, or a local agency, a traffic control plan for a temporary construction entrance. If necessary, the requirements of the plan will be outlined in the specifications.

The specifications will include a section for access and haul roads that will detail the requirements by which the Contractor must abide during construction. The use of a flagman when truck traffic is entering and exiting the highway will also be evaluated and specified, if appropriate.

3.3 Erosion and Sediment Control

In accordance with ROD Section VIII.B.2, this section of the report addresses the erosion and sediment control devices that will be implemented on the upland work areas. This section does not address the Delaware River area of the project, which is addressed in Section 3.13 of the report.

One of the first elements of construction will be the installation of perimeter erosion and sediment control devices. Perimeter erosion control features may include a stone construction entrance, silt fence, hay bales, rock check dams, or other erosion control elements. Silt fence will be required to be installed around the downgradient perimeter of the site, as shown on Drawing C-1 in Appendix 2. Drawings C-19 and C-20 include erosion control details and have also been included in Appendix 2 but have not been made site specific with this submittal. The stone construction entrance will be required to be installed immediately inside of the public roadways. Hay bales and rock check dams will be required at points of channeled flow and around any inlets or outlets.

The design of site surface features will include more permanent erosion control components, utilizing turf reinforcement technologies and other Best Management Practices as encouraged by the PADEP water quality regulations, 25 PA Code Chapter 102, and the local County Soil Conservation Districts. These practices will include the use of turf reinforcement fabrics in drainage channels and on any slopes to stabilize and control erosion at the site. All stormwater calculations and drainage design will be conducted during future design components. Drawings C-21 and C-22 will also be included with the future design deliverables. Some

typical manufacturers cut sheets of the products that will be specified during the future design are included in Appendix 3, Erosion and Sediment Control Information.

3.4 Clearing and Grubbing

Clearing and grubbing is not considered to be a major component of the design. In general, the Contractor will be required to clear all areas of the site necessary for construction activities. All material from clearing operations will be required to be shredded into chips, and the chips will be required to be dispersed beneath the soil cap.

3.5 Courtyard Area Soil Excavation

In accordance with ROD Section IX.A.1, the soil sampling program for the Courtyard Area was conducted during the PDI to further refine the volume estimates and extent of soils exceeding the 10-ppm action level for PCBs established in the ROD that were identified during the RI and FS. Soil samples were collected around the outside perimeter of the areas of concern to determine the boundaries and limits for future remediation. The results of the sampling effort were successful, and the boundary and limits for future Remedial Design were determined. The area is slightly larger than the area identified in the ROD. Information obtained from the PDI has been used to develop design criteria for excavation, staging, waste disposal, and restoration of impacted soils in the Courtyard Area.

Two areas of concern were identified in the RDWP for sampling. Drawings C-4 and C-5 in Appendix 2 show the limits of the soil excavation that will be required to be performed by the Contractor as part of the remedial action. Based on a USEPA split sample, these limits have been adjusted further out and a post-excavation sample will be required. The Contractor will be required to survey the area and lay out the excavation with survey stakes prior to excavation and to excavate a 2-foot depth within that area. The Contractor will also be required to survey the area upon completion and obtain the Engineer's acceptance of the survey prior to placement of backfill in order to confirm that the excavation was completed to the limits established during the

Preliminary Design investigation. During this inspection, the Engineer will also examine the side walls of the excavation for any visual evidence of contamination to determine if any confirmation sampling or additional excavation is necessary. This process will be clearly indicated in the specifications.

3.6 Soil Stockpile Area Construction

In accordance with the ROD, Section IX.B, soil excavated from the areas of concern will be stored in accordance with applicable regulations and sampled to determine the appropriate disposal methods. The volume of soil that is expected to be excavated is approximately 12,000 cubic yards; it would be impractical to utilize roll-off storage containers, as over 900 roll-off containers would be required. Therefore, a temporary storage pad will be designed for stockpiling of the soil. The storage pad will be constructed of an impervious surface consisting of concrete and will have a containment curb around the perimeter. Drawing S-4 in Appendix 2 shows the proposed location of the soil stockpile area and decontamination pad. Drawings C-13 and C-14 show construction details.

At the end of each day and during periods of rain, soil piles will be required to be covered with impervious tarps to prevent the infiltration of storm water. The storage pad will also drain to a collection sump where water will be pumped through a treatment system to treat water to discharge standards. Initially, the water will be stored in tanks; sampled to confirm that it is below the discharge standards; and discharged either to the Delaware River, to an onsite location for dust control, or to the sanitary sewer system. The Contractor will be required to treat any water to the required discharge standards as part of a performance specification. Construction water management and treatment will be the Contractor's responsibility. During the future design, the discharge point and sampling frequency will be determined. The same treatment system will be used to treat any water from excavations and any water generated from dewatering sediments or placing sediments within the excavations.

Drawing C-13 in Appendix 2 shows a proposed soil stockpile area. Drawing C-14 in Appendix 2 shows the proposed vehicle decontamination pad for vehicles leaving the stockpile area. The Contractor will be given the option to alter the size of the soil stockpile area or propose an alternate stockpile area or method. The stockpile area will contain separate bins for segregating soil piles. The Contractor will also be required to verify the designed concrete pad is adequate for the equipment that the Contractor intends to use on the project. Any alternate design will be subject to the approval of the Engineer and will be required to be at least as protective of the environment as the proposed design. Some typical manufacturers' product sheets for the materials that will be used to construct the soil stockpile area and stockpile covers are included in Appendix 4, Soil Stockpile Area Information.

At the completion of construction, the Contractor will be required to remove and dispose of the concrete pad and sample beneath the pad to confirm contamination did not penetrate the pad. Concrete pad disposal will be the Contractor's responsibility. In the event that the Contractor can demonstrate that the concrete pad does not contain PCB concentrations above 25 ppm, the concrete pad may be broken into manageable pieces and used to backfill excavations in a controlled manner requiring alternating lifts of soil and concrete.

3.7 Sheet Pile Wall Installation

In accordance with Section IX.C.1 of the ROD the installation of a sheet pile wall is required around the southern portion of the site to control erosion and to assist with the collection of oil. Based on the findings of the PDI, an alternative to optimize the sheet pile wall around the areas of primary concern is being proposed as part of this Preliminary Design. Descriptions of the alternative are provided in Section 4.2 of this report. The proposed location of the sheet pile wall is presented on Drawing C-26 of Appendix 2.

The specifics regarding the sheet pile wall will be determined during the future design phases. These specifics will include the final location and extent of the wall, the bottom elevation or driven depth of the wall, and the top elevation of the wall. Additional details regarding the tie

backs, anchoring, backfill, and any required erosion protection in front of the wall will also be determined during the future design phases.

Ogden and Hart Crowser are currently considering both steel and vinyl as the materials for construction of the sheet pile wall. The advantage of steel is its structural strength and it is the more probable choice for this application. The advantage of vinyl is its increased life expectancy. Information regarding both materials is included in Appendix 5, Sheet Pile Wall Information.

3.8 Underground Storage Tank Closure

In accordance with Section IX.D.1 of the ROD, Ogden located and uncovered the UST located in the Southern Area, as shown on Drawing S-2 in Appendix 2, to design the closure of the UST. The details of the investigation will be conveyed to the Contractor with the directives of what is required to be performed to complete the UST closure on Drawing C-2. Additional details, including tank size, cover material, and materials of construction, will be presented on Drawing C-23, which will be developed during Intermediate Design. Detailed specifications will be developed to ensure the tank closure is performed in accordance with applicable regulations, including 40 CFR Part 280 Subpart G. The tank contents will be required to be disposed of in accordance with applicable regulations. Tank excavation soil sampling will not be required because the tank is within the limits of SA4/5, which will be required to be excavated. The tank closure will be scheduled to take place at the beginning of the soil disposal activities in the Southern Area Soil Excavation in Area SA-4/5.

3.9 Southern Area Soil Excavation

In accordance with Section IX.A.2 of the ROD, the soil sampling program for the Southern Area was conducted to further refine the volume estimates and extent of soils exceeding the 25-ppm action level for PCBs established in the ROD that were identified during the RI/FS. Soil samples were collected around the outside perimeter of the areas of concern to determine the

boundaries and limits for future remediation. The results of the sampling effort were successful, and the boundary and limits for future Remedial Design were determined. The area is slightly larger than the area identified in the ROD. Information obtained from the pre-design samples has been used to develop design criteria for excavation, staging, waste disposal, and restoration of impacted soils in the Southern Area.

Four areas of concern were identified for excavation based on the sampling results of the PDI. Drawing C-4 in Appendix 2 shows the limits of the soil excavation that will be required to be performed by the Contractor as part of the remedial action for the areas of concern. The Contractor will be required to survey the area and lay out the excavation with survey stakes prior to excavation and to excavate to the contours shown on Drawings C-5, C-6, and C-7 in Appendix 2 for each area of concern. Drawings C-15 and C-16 in Appendix 2 show excavation cross sections. The Contractor will also be required to survey the area upon completion and obtain the Engineer's acceptance of the survey prior to placement of backfill. During this inspection, the Engineer will also examine the side walls of the excavation for any visual evidence of contamination to determine if any confirmation sampling or additional excavation is necessary. This process will be clearly indicated in the specifications.

3.10 Floatable Oil/LNAPL Collection System

In accordance with Section IX.C.2 of the ROD, Ogden conducted a floatable oil/LNAPL investigation at the site, which included installing piezometers and measuring for oil. The piezometers were installed along the water side perimeter of the site to determine if floatable oil/LNAPL is present on the water table at the site along the proposed alignment of the oil collection system as required by the ROD. The investigation was designed to determine the existence, extent, and relative apparent thickness of any LNAPL that may remain at the site.

During the PDI, MW-6 was investigated as it had been found to contain oil during previous investigations. When MW-6 was approached, it was found that there was no lock on the well and the open well contained a bailer. The well was observed to contain water with no

evidence of oil or LNAPL. Based on the fact that the lock was missing, Ogden decided that the information gathered from that well was compromised and did not include the well in the determination of the limits of LNAPL or as a data point on Table 4-3 of the PDI Report.

During the final floatable oil/LNAPL measurement, the recorded results indicated that three wells contained measurable floatable oil/LNAPL and three wells contained a presence or sheen of floatable oil/LNAPL. All of these wells were located in a limited small portion of the site. Based on the limited amount of oil present at the site, the PRP Group, Ogden, and Hart Crowser have determined that an alternative to the oil collection system proposed in the ROD is appropriate. This alternative is presented in Section 4.1 of this report.

3.11 Soil Disposal

In accordance with Section IX.B of the ROD, during excavation, the Contractor will be required to stockpile separately soils expected to exceed 50 ppm from soils that are possibly above 25 ppm but not above 50 ppm PCBs. Overburden soils, which are expected to be below 25 ppm, will also be separated. Soil will be stockpiled in approximately 150-cubic-yard piles, and a composite sample will be collected from each pile by the Contractor for PCB analysis at a USEPA-approved laboratory. All soil sampling will be performed under the inspection of the Engineer. The result of the analysis will be used to determine the offsite disposal required for the soil. Soil with total PCB concentrations below 25 ppm will be used for onsite backfill and for grading fill below the 2-foot soil cap. Soil with total PCB concentrations between 25 ppm and 50 ppm, and that also is non-hazardous, will be disposed of in a Subtitle D landfill. Soil tested to have PCB concentrations above 50 ppm will be disposed of in a TSCA-regulated landfill.

The ROD indicates that the soil must be tested for other disposal characteristics to determine if soil below 50 ppm is required to be disposed of in a Subtitle D Landfill or a Subtitle C RCRA Hazardous Landfill. During the PDI, Courtyard Area surface soil samples and Southern Area soil samples were analyzed for full TCLP and asbestos for disposal characterization purposes. No constituents were detected in the samples analyzed for TCLP at concentrations exceeding the

USEPA Regulatory Levels contained in 40 CFR § 261.24. Asbestos was detected at a concentration of less than 1 percent in three soil samples from the Southern Area: MB-SAB-11-06, MB-SAB-15-08, and MB-SAB-19-09. None of the seven remaining samples contained detected concentrations of asbestos.

These results will be made available to the Contractor. Based on these results, it is believed that the soils below 50 ppm of PCB at the site are not hazardous and will be required to have additional TCLP or other disposal analysis only to the extent that it is required by the Contractor's disposal facility.

3.12 Soil Cover Installation

In accordance with Section IX.A.6 of the ROD, the installation of a 12-inch soil cover in the Courtyard Area and a 24-inch soil cover in the Southern Area is required. The limits of the soil cover areas are shown on Drawing S-4 in Appendix 2. The areas will be graded in accordance with appropriate storm-water management practices to allow for drainage from both areas in accordance with PRWM Regulations at 25 PA Code Chapter §§ 288.234. Site soils will be used for grading purposes to the extent that the grading activities do not significantly disturb the surface. Excavated material that was found to be below 25 ppm will also be used for grading purposes. A minimum of imported fill will be utilized for grading purposes.

As part of the preparatory grading activities, the excavations must be filled with soil to bring them back to existing grade. Sediments excavated from the Delaware River will be used for this purpose. The sediments will be placed in the upland excavations in approximate 12-inch lifts and properly compacted. The broken concrete from the existing stockpile will be installed to help stabilize and compact the sediments. It may be necessary to perform dewatering of the sediments by installing a sump in the excavation or allowing them to drain above grade prior to placement within the excavation. The details of this activity will be developed in the specifications during the future design phases.

The preparatory grades to be established once all excavation is complete will be determined during future design phases. Once the areas are properly graded, a lightweight geotextile will be placed over the graded material to serve as a marker between the site soils and cover soils. The geotextile will be used to provide a uniform consistent barrier as opposed to the marking tape specified in the ROD. The geotextile will also allow for verification of the 2-foot soil thickness and prevent the mixing of site soils with cover soils. The geotextile will prevent the migration of fines during flood conditions and will eliminate the potential upward migration of PCB contamination attached to soil particles. Therefore, the geotextile will eliminate the need for a soil monitoring program required by the ROD. This is further discussed in Section 4.0.

The cover soils will be specified and placed in a northwest to southeast direction so that cross contamination of the clean cover soil does not occur. Cover soil placement will be specified after sediment excavation and placement is complete. Cover soil will be specified to include materials meeting the requirements of Pennsylvania Code Title 25, Waste Management Regulations.

The vegetation specifications will require the testing of the cover soil to determine the adequacy for vegetation. In the event that the cover soil does not contain adequate organic materials to support vegetation, soil amendments will be specified.

3.13 Delaware River Area Sediment Excavation

In accordance with ROD Section IX.A.3 and AO requirement III.E.4.a, the Delaware River area sediment excavation and backfill design is intended to satisfy the following objectives:

- Remove contaminated sediments exceeding target PCB levels of 1 ppm
- Prohibit contaminant migration caused by resuspension of contaminated sediments
- Minimize time required for construction
- Minimize impacts to the surroundings during construction.

The sediment excavation design will also contain scheduling and operational specifications that meet the intent of all local, state, and federal regulatory requirements. Accommodation of vessel traffic and coordination with other works occurring in the project area will be required.

Ogden and Hart Crowser propose to implement three alternatives for the remediation of the sediments in the Delaware River. Those alternatives, and their rationale, are discussed in Sections 4.3 through 4.5 of the report. The following sections are written based on the USEPA's February 7, 2000 indication that those alternatives will be approved following preparation of an Explanation of Significant Difference (ESD) by the USEPA.

3.13.1 Sediment Excavation Limits

Delaware River Area sediment sampling was undertaken during the PDI to supplement existing data and to further delineate the horizontal and vertical extent of PCB concentrations in the sediments exceeding the 1-ppm action level. The most recent results indicate the distribution of PCB-contaminated sediment remains similar to the distribution seen in the earlier data. In general, levels of contamination are higher near the southwest and southeast corners of the site and decrease away from those areas.

Figure 1 presents an initial interpretation of the areas to be remediated based on an interpretation of the PDI data supplemented by the RI data. Excavation limits are presented on Figure 2 and Sheets C-27 and C-28. The limits of dredging slightly exceed the limits of the area to be remediated for ease of construction and to accommodate reasonable standards of dredging control.

The areal extent of sediments with PCB levels generally above 1 ppm is based on the PDI data and supplemented by the earlier data collected during the RI. Based on this initial evaluation, all PDI sample points with PCB levels above 1 ppm are included within the areas to be

remediated. PDI sample points with PCB levels below 1 ppm are included within the areas to be remediated where the general distribution of RI data indicate a pattern of values above 1 ppm. Where resampling during the PDI or the general distribution of PDI data indicates current levels are below 1 ppm, some points with RI data above 1 ppm have been excluded from the area to be remediated.

Sample points from the RI with values above 1 ppm that are not included in the areas to be excavated are MF3, MF11, MF137, S5, and S9. MF3 and MF11 were resampled during the PDI, and PCBs were not detected. These current results, in association with earlier duplicate/resampling results below 1 ppm, are the rationale for placing them outside of the excavation area.

Sample location RD28 was located adjacent to MF137 and had no detectable levels of PCBs. Other RD sample points in the vicinity of MF137 also had no detected PCBs. RI data surrounding MF137 (MF136, S12, and S13) were all below 1 ppm and the exceedence at MF137 was based on field test kit results. Based on the newest data and general trends in all data for the area, the sediment remediation boundary has been placed inshore of MF137.

PDI data collected surrounding S5 (RD3, RD4, RD7A, RD9, RD8, and RD6) are consistently below 1 ppm with over half of the samples having no detected PCBs. Based on these new data, the area has been placed outside of the sediment remediation zone. PDI data collected surrounding S9 (RD9, RD10, RD12) all show no detectable levels of PCBs, and this area has also been placed outside of the zone of sediment removal.

Depth of dredging is also presented in Figure 1 and is based on the PDI data supplemented by the RI data. In general, the depth of remediation for most of the area adjacent to the southwest corner of the site is 2 feet. The PDI data indicate one zone where excavation will need to extend to 4 feet, and this is supported by the RI data. Data collected during the RI in the riprap zone along the southwest corner indicate some areas with contamination above

1 ppm, but well below 25 ppm to depths below 2 feet. These areas will be contained behind the sheet pile wall being placed at the toe of the slope.

Dredging depths to 4 feet in the areas of remediation off of the southeast corner and upriver are more common. The PDI and RI data both support the patterns presented on Figure 1. The depths of dredging on Sheets C-27 and C-28 exceed the limits presented on Figure 1 for the reasons discussed below.

3.13.2 Sediment Excavation

Sediment excavation will be performed using a closed clamshell bucket, backhoe, or other acceptable low-impact, environmentally sound excavation equipment. The primary purpose for this restriction is to minimize the amount of sediment suspension during operations. Although elutriate testing during the PDI showed no PCBs in the elutriate water and only minimal (ppb) levels associated with the elutriate sediment, low-impact techniques will further lower the potential for contaminant migration during dredging. Dredging using low-impact environmental techniques is a well-established practice, and numerous contractors are qualified to perform the work. Sample contractor references pertaining to environmental dredging of contaminated sediments are included in Appendix 6.

Upland equipment utilized onsite will be subject to load restrictions in the vicinity of the shoreline sheet pile wall that will be constructed. These restrictions will be specified as part of the contract documents. Considering these restrictions, the Contractor will be responsible for determining the applicability of various land-based and water-based construction methods. The Contractor will be free to construct temporary load-bearing improvements to the wall, provided they meet the approval of the Owner. The Contractor will be responsible for any placement of loads in excess of the maximum specified limits.

The sediment excavation designs are presented on Sheets C-27, C-28, and C-29 of the construction documents. The design meets the minimum excavation requirements depicted in Figure 1. Note that the excavation area is defined by straight lines rather than the curvilinear areas illustrated in Figure 1. These straight-line areas totally encompass the curvilinear areas; therefore, all minimum excavation requirements are met. Figure 2 illustrates the relationship of the two plans. The specification of straight-line dredge areas is standard practice in marine engineering. It is intended to ease project construction and recognizes reasonable standards of dredging control. The negative aspect of this approach is that it results in greater volumes of dredged sediments and backfill materials than are actually required to meet cleanup criteria. The design presented herein minimizes the additional volume.

3.13.3 Backfilling of Sediment Excavation

In accordance with Section IX.A.6 of the ROD, all areas of sediment excavation will be backfilled with clean material. The backfill will consist of clean material that is slightly coarser than the site's existing surface sediments. Consequently, the likelihood of erosion of this material will be reduced and benthic habitats will not be significantly altered. It is likely that locally dominant benthic habitat conditions will be established soon after construction due to the content of suspended sediments in the water column and shallow water sediment transport conditions. Exact specifications for the backfill sediments will be determined in subsequent design efforts. The Contractor will be required to submit representative samples and laboratory testing results for approval by the Engineer of its proposed backfill prior to construction. The Contractor will be required, at its own expense, to remove any sediment delivered to the project area that is not consistent with the representative samples.

Prior to backfilling, excavation areas will be surveyed to confirm that the excavation has extended to at least the boundaries defined by the Excavation Area Control presented on Sheets C-27 and C-28 and to at least to the depths presented. Placement of backfill material will be performed using a clamshell bucket, backhoe, or other acceptable excavation

equipment that can perform the work in a low-impact, environmentally sound manner. Rate and techniques of placement will be restricted in the specifications to minimize the resuspension of bottom sediments during placement. Turbidity control will remain in effect during backfill placement. The backfilled areas will be surveyed to confirm placement to the required lines and grade.

3.13.4 Upland Placement of Dredged Material

In accordance with Section IX.A.6 of the ROD, dredged material will be placed at upland location(s) on the Southern Area of the site. The primary placement location will be Area SA 4/5 following removal of the upland contaminated materials. Data collected during the PDI indicate that all sediments to be excavated have PCB levels well below the 25-ppm criteria, are not hazardous, and do not contain asbestos. The water collection and water treatment system used for groundwater control during the upland excavation will also be used to manage water associated with the excavated sediments. Elutriate test data from the PDI will be provided so the Contractor can incorporate that information into the development of the water treatment system to be used. Treated water will be returned to the Delaware River, within the confines of the turbidity curtains or as otherwise determined during later design phases. The water outfall will be diffused using a plate or other diffusing device.

The Contractor will be responsible for determining appropriate methods for the transport of dredged material from the excavation site to the disposal site and placement of the material primarily in area SA4/5. As noted previously, there will be upland load restrictions in the vicinity of the shoreline retaining wall. These restrictions will be specified as part of the contract documents.

3.13.5 Turbidity Control

Control of turbidity during excavation operations will be accomplished with a turbidity curtain system. This alternative was deemed superior to structural solutions such as sheet pile walls and cofferdams. Advantages of the turbidity curtain system include its relative ease of construction, ability for adjustment, limited disturbance of bottom sediments during installation and removal, and savings in time and cost. It is recognized that the effectiveness of turbidity curtains is limited by environmental conditions such as currents and tidal range; however, the conditions in the project area are sufficiently mild to allow a properly engineered system to perform adequately. The need to impose operational restrictions will be evaluated during future design. Appendix 7 provides product literature from turbidity curtain vendors that illustrates the applicability of their products.

Drawings in Appendix 2 of the construction documents illustrate preliminary turbidity curtain design concepts. Conditions may require that an outer curtain and inner curtain be deployed during all excavation and backfill operations to the extent that a single curtain is not sufficient. This determination will be made as part of the detailed design. Other concepts illustrated in the Appendix 2 drawings, such as the deflection wall and the anchoring alternatives, are still being evaluated. During detailed design, the need to incorporate these features will be determined. If the use of alternatives is necessary, the best alternative for installing them will be selected.

Outer Curtain. The outer curtain would be constructed of a high strength material similar to the American Marine, Inc. RUFFWATER® curtain. This is a heavy-duty product designed to withstand wind, waves, and current. Its configuration is designed to avoid 90-degree angles to the current. This configuration minimizes anchoring requirements and optimizes curtain effectiveness. Actual anchoring requirements have yet to be determined. A more porous material that is permeable to water but impermeable to sediment will also be evaluated.

Additional hydrodynamic data may be required to finalize the turbidity curtain's configuration and anchoring requirements. The proposed data collection effort would result in the measurement of current and water level data over a one-month period, including spring tides. Options for the curtain's configuration include the construction of a structural deflecting wall. This wall would most likely be located at the down drift end of the study area and would deflect flood currents from the south. An example configuration of this option is illustrated in Figure 3. Anchoring options for the turbidity curtain range from standard seabed anchors to driven piles. The mudflat area will require special consideration, as it is primarily dry at low tide.

The outer curtain will require navigation markings in accordance with Coast Guard regulations. Markings will be specified and will be the responsibility of the Contractor.

Inner Curtains. The inner curtains would be constructed of a medium-strength material similar to the American Marine, Inc. FASTWATER® curtain. This product is a medium-duty curtain designed to withstand mild wind, waves, and current. Inner curtains will be deployed around the limits of each of the dredging areas during dredge and fill activities. They must be adjustable to allow transport of scows or other equipment in and out of the work areas. However, all excavation and fill operations must cease at least 6 hours prior to such curtain openings. An inner silt curtain must also enclose all offloading operations undertaken to transport material to the upland. The anchoring systems for the inner curtains have yet to be designed. It is likely that the relatively quiescent conditions within the outer curtain will permit standard anchoring.

Operational Restrictions. It is recognized that the effectiveness of turbidity curtains decreases with increases in water currents. Consequently, dredge and fill operations may be prohibited during extreme portions of the tidal current cycle and during flood periods. Preliminary analysis indicates that the current threshold will be in the range of 1.5 fps to 2.0 fps. The proposed hydrodynamic data collection effort may be needed to better define this criteria. It is anticipated that a specific threshold will be specified; however, this value may be

modified during the course of the work if the performance monitoring of turbidity levels indicates it is necessary

The Contractor will be responsible for the installation, adjustment, maintenance, and repair of all turbidity control equipment. Exceptional meteorological conditions (i.e., floods, hurricanes) may require the temporary suspension of work during construction.

3.14 Fence Installation

The existing fence is in poor condition and does not surround the entire site. In accordance with Section IX.E.1 of the ROD, a new 6-foot-high galvanized steel fence will be installed around the entire property. Drawings C-17 and C-18 in Appendix 2 provide the location and details of the chain-link fence. The Contractor will be required to install the chain-link fence around the land-bound portions of the site at the beginning of construction. The waterfront portion of the chain-link fence will be required to be installed at the completion of construction so as to prevent damage of this area during construction activities and to allow the fencing to be installed after the final grading and cover soil installation has been completed. The fence post will be designed so as not to penetrate the cover soil thickness.

The existing gates will be replaced with similar gates. In addition, one gate will be specified to be added at the main construction entrance along Milnor Street for truck traffic.

The other element of institutional controls includes deed restrictions, which are required to be placed on the property. Deed restrictions are the responsibility of the Property Owner and are not addressed as part of this Remedial Design.

3.15 Signs

In accordance with Section IX.E.2 of the ROD, signs will be posted along the property boundary, including the river side, on the chain-link fence and will provide a warning regarding PCBs. The exact wording of the signs will be coordinated with the USEPA,

PADEP, and the Fish and Boat Commission. The signs will be mounted to the chain-link fence. Specific wording and requirements for spacing of the signs will be specified in the chain-link fence section of the specifications.

3.16 Groundwater Monitoring Program

Section IX.G.1 of the ROD requires a monitoring program for site groundwater to evaluate the effectiveness of the remedy in reducing concentration of PCBs and other contaminants in groundwater. As the design progresses, Ogden and Hart Crowser will develop the details for the monitoring program, which will include the exact locations, the frequency and duration of sampling, and the analytical parameters and methods to be used. Ogden's intention is to develop the details of the monitoring program that the Contractor must implement. The monitoring program will begin as a pre-construction activity to establish the baseline concentrations of the contaminants of concern. At a minimum, MW-6 and MW-7 locations will be sampled quarterly and analyzed for PCBs, pesticides, metals, SVOCs, and VOC, as specified in the ROD. The program will be evaluated after 3 years to determine if changes are appropriate.

3.17 Delaware River Monitoring Program

Section IX.G.2 of the ROD requires a monitoring program for the Delaware River to evaluate conditions of aquatic species in the Delaware River at the site before, during, and after the remedy has been implemented. This program will include chemical and biological monitoring and will be evaluated after 5 years to determine if changes are appropriate. The monitoring program will be established based on the limits of excavation when they are finalized. The method of excavation and the silt/turbidity controls selected will also be considered when developing the monitoring program.

As the design progresses, Ogden and Hart Crowser will develop the details of the monitoring program that the Contractor must implement. The monitoring program will be one of the first pre-construction activities that the Contractor is required to implement in order to obtain the

information that is required prior to construction. The schedule will accommodate this approach because the Delaware River sediment excavation is one of the final elements of construction.

During the future design phases, the details of the chemical and biological monitoring program will be developed and written into the construction specification. These details will include the number and location of sample events, procedures and analytical methods to be utilized, and other site-specific elements of the monitoring program. The goal is to select techniques and sample locations to verify the success of the remedial action at the site that will not be heavily influenced by other activities within the vicinity (e.g., sediment deposition from other sources within the watershed). Of particular significance will be the determination of background conditions and selection of appropriate reference locations that must have similar hydrological conditions, similar inputs from the surrounding watershed, and be in a similarly developed portion of the estuary. Input provided by the USEPA and other resource agencies with the review of the design deliverables will also be incorporated into the design.

3.18 Baxter Water Treatment Plant Intake Sampling

Section IX.G.3 of the ROD requires the continued sampling of the Baxter Water Intake prior to performing any construction activities, during construction, and for one year following completion of construction of the remedial activities. The ROD required action to be taken if drinking water from the influent exceeds the Safe Drinking Water Act Maximum Contaminant Level for PCBs (confirmatory sample taken immediately and notification of the officials at the Baxter facility) will also become a requirement of the remedial action contract. Ogden will continue the quarterly sampling to ensure that PCBs are not present in the Baxter Water Intake during the Remedial Design Phase. The results of the quarterly sampling events will be provided with the monthly progress reports.

4.0 ROD REMEDY AND ALTERNATIVES

The PRP Group and Ogden and Hart Crowser have developed alternatives incorporating different and better technologies, different site conditions discovered during the PDI, and different or more innovative approaches to construction to implement the remedial action. Ogden and Hart Crowser have discussed many alternatives with the USEPA at meetings in October 1998, July 1999, November 1999, and January 2000. As the project progressed, the list of alternatives that will be pursued was refined and narrowed based on PDI findings, input from the USEPA, and additional research.

As discussed with the USEPA on January 28, 2000, the PRP Group and Ogden and Hart Crowser have reviewed the ROD remedy and the data obtained during the PDI to ensure the ROD remedy is appropriate for the site, based on the current conditions at the site. This review was also intended to identify areas where the ROD remedy could be adjusted to accommodate the current site conditions and to provide for a more expedient and effective solution, while continuing to meet the objectives and goals of the ROD. This section of the report includes a discussion of these alternatives or adjustments for approval by the USEPA.

A table of the alternatives that were considered is included as Table 1. Ogden used the USEPA Document EPA/540/G-90-007, "Guidance on Remedial Actions for Superfund Sites with PCB Contamination" (EPA, 1990), in the process of evaluating the alternatives listed in Table 1. In addition, a minor modification with regard to the future monitoring program has been added to this list. The following alternatives were selected from this table to be retained for submission to and approval by the USEPA as requested in the USEPA letter dated February 16, 2000.

- Excavation instead of oil collection system.
- Optimization of the sheet pile wall.
- Excavation of sediments based on 1-ppm action level.
- Elimination of the need for dewatering.

- Containment of suspended solids with a turbidity curtain.
- Elimination of soil monitoring program.

The USEPA letter dated February 16, 2000 indicated that Alternatives 2 through 5 will be approved with an Explanation of Significant Difference. With respect to the first alternative, the intent of this presentation is to provide the USEPA with information necessary to evaluate the alternative as part of the focused feasibility study that the USEPA has indicated will be performed.

This section of the report was prepared using USEPA Document 540-R-98-031, "A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents" (EPA, 1999), as a guide. Specifically, the individual alternative sections were intended to follow the format of Highlight 7-2 of the guidance document. The intent of this presentation was to provide the USEPA, which is the lead agency, as well as the support agencies with the information necessary to develop the Explanation of Significant Difference required to implement the alternatives to the ROD executed on December 31, 1997 for the Metal Bank Superfund site in Philadelphia, Pennsylvania. These alternatives, which are discussed in this section, can be implemented in accordance with CERCLA Section 117(c.) and NCP Section 300.435 (c.)(2)(l). An electronic copy of this section can be made available to the USEPA.

These alternatives will provide for the most cost- and time-effective ROD remedy with the least disturbance of the environment, while meeting the goals and objectives of the ROD and providing a more permanent solution that requires the minimum amount of operation and maintenance.

4.1 Excavation Instead of Oil Collection System

The Metal Bank site has been determined by the USEPA to be a source of LNAPL entering the Delaware River and contaminating the waters of the State. The LNAPL/oil collection

system is intended to remove LNAPL that is allegedly entering the Delaware River over time through seeps along the shoreline. It is only appropriate to design the LNAPL collection system based on and addressing the area and extent of LNAPL currently present at the site.

4.1.1 Selected ROD Remedy

Section IX.C of the ROD states that "Prior to excavation of soil from the Southern Portion of the property an oil collection system consisting of interceptor trenches, oil water separators, and sump pumps, or similar collection devices shall be installed to collect oil floating on the shallow groundwater at the site to prevent PCBs in oil from getting into the Delaware River." The ROD also discusses the installation of a sheet pile wall associated with the oil collection system, which is discussed in Section 4.2 of this report, and discusses the disposal of any collected oil or water in accordance with appropriate regulations.

4.1.2 Basis for Remedy Explanation of Significant Difference

The ROD assumed that there may be a significant and collectible volume of LNAPL present at the site and that it was continuing to be an ongoing source of contamination in the Delaware River. The PDI identified LNAPL in the Southern Area of the site in six of the 12 piezometers installed. After the piezometers were developed, it was further determined that the LNAPL was present, but not in a measurable or recoverable thickness, in three of these six wells. Of the three remaining wells, only one was found to have more than an inch of LNAPL. Figure 4 shows the limits of LNAPL identified during the PDI. Therefore, the extent of LNAPL is less than assumed in the ROD. In addition, the subsurface material at the site was found to be heterogeneous and contained a great deal of debris, which would make an oil collection system for this limited amount of LNAPL impractical to operate.

The sampling during the PDI has determined the limits of soil containing concentrations of PCBs in excess of 25 ppm in the Southern Area. Excavation limits of the soil with concentrations above 25 ppm in Area SA4/5 have been determined to be greater than the area identified in the ROD. This area also includes five of the six piezometers that contained LNAPL during the PDI. Excavation of the soil containing greater than 25 ppm will also require excavation 1 to 3 feet into the groundwater table within the area that contains LNAPL.

4.1.3 Description of Significant Difference to ROD Remedy

Ogden and Hart Crowser believe that the excavation of the SA4/5 area will eliminate almost all LNAPL found at the site during the PDI. The one remaining piezometer (BP-9) is outside the SA4/5 excavation area and was found to contain a presence of LNAPL, but not a measurable thickness. During this excavation, the Contractor will be required to remove any LNAPL found to be present on the groundwater table with booms or pumps based on the quantity that is encountered.

To ensure the LNAPL has been removed, the excavation side walls will be inspected when they are open, and any side wall exhibiting a measurable thickness of LNAPL will be excavated. The above procedures, when implemented, will effectively eliminate the presence of LNAPL from the site. Therefore, the goal of the LNAPL collection system will be achieved during the implementation of the soil excavation portion of the Remedial Design and will entirely eliminate the need for an LNAPL collection system. Figure 5 shows an overlay of the excavation limits and LNAPL presence. Drawing C-7 of Appendix 2 shows the limits of soil excavation and potential additional limits for the LNAPL excavation.

Ogden and Hart Crowser believe that the installation of an LNAPL collection system would be impractical based on this information and the findings of the PDI. Although LNAPL exists at the site, it is limited in extent and thickness, and recovery in heterogeneous soils may not be feasible. With the exception of one piezometer, the LNAPL identified in the piezometers

during the PDI is within the limits of the area that must be excavated to remove soils above 25 ppm in SA4/5. Excavation will eliminate the contaminated soils that potentially represent a source of LNAPL, in addition to the LNAPL that is currently known to be present.

Ogden and Hart Crowser propose to prepare the design to require, as part of the construction process and at the completion of soil excavation, inspection for and removal or excavation of any LNAPL found during excavation in the SA-4/5 area. This alternative may also result in a moderate cost savings, depending on the amount of excavation required.

4.2 Optimization of Sheet Pile Wall

The Metal Bank site has been determined by the USEPA to be a source of LNAPL entering the Delaware River and contaminating the waters of the State. Based on the ROD, the sheet pile wall is intended to serve two purposes: one is to assist with the collection of LNAPL, and the second is to prevent erosion from the site. The sheet pile wall system should be designed based on the extent of LNAPL and should address the area of LNAPL contamination.

4.2.1 Selected ROD Remedy

Section IX.C of the ROD states, "Prior to excavation of soil from the Southern Portion of the property, a sheet pile wall shall be installed around the southern and western perimeter of the property adjacent to the Delaware River to prevent erosion of fill materials into the river and facilitate installation of the oil collection system."

Section IX.B.5 of the ROD states, "Oversized materials such as boulders in the Riprap Area and debris from the Southern Portion shall be decontaminated, using steam cleaning or other equivalent method, in order to reduce PCB concentration on its surfaces." The ROD also discusses the disposal of any collected oil or water in accordance with appropriate regulations.

4.2.2 Basis for Remedy Explanation of Significant Difference

As discussed earlier, the LNAPL identified at the site during the PDI is limited in thickness and areal extent. The required excavation will remove the LNAPL identified. The sheet pile wall should be limited to the length of the shoreline in the southern corner of the site where LNAPL was detected in piezometers, and where soil contamination exceeded 25 ppm, to further ensure the elimination of any release of PCBs into the Delaware River. The limits are shown on Drawings C-26 and C-27 in Appendix 2. Also, the sheet pile wall should be placed at the toe of the riprap for at least two reasons: it would be impractical to install a wall through the debris and irregular site soils in this area, and the wall can contain any residual contamination currently existing on the riprap.

Erosion at the site presently appears to be limited due to the large concrete blocks used to fortify the outward slope of the site. These large concrete blocks appear to be from previous building demolitions and some are more than 5 feet in diameter. Limiting the sheet pile wall to the areas where LNAPL was identified and incorporating the limited sheet pile wall and the contaminated soil excavation into the storm-water management design will prevent erosion from the site. The cleaning of contaminated riprap would be difficult based on concrete adsorption of PCB contamination and would also be difficult to implement based on the large, irregular, and unmanageable pieces of concrete fortifying the slopes of the site, particularly along the Delaware River.

4.2.3 Description of Significant Difference to ROD Remedy

The wall described will prevent erosion from the site and, if installed at the toe of the slope, will contain any potentially contaminated riprap and decrease some of the sediment excavation. The riprap has also stabilized over time, and disturbance would impact and reduce this

stability. The location shown on Drawing C-28 is the most likely area where any residual contamination expected to be below 25 ppm would remain and where erosion could potentially cause a release of PCBs to the Delaware River.

Ogden and Hart Crowser propose to design the sheet pile wall to be limited to the area where LNAPL and the most extensive soil contamination were found during the PDI. The sheet pile wall will also be designed to rest at the toe of the slope to contain any residual contamination that might exist in the riprap along the shoreline of the site. This alternative will result in a significant cost savings.

4.3 Remediation of Sediments Based on 1-ppm Action Level

The ROD and the AO are inconsistent with regard to the excavation of sediments. The ROD requires excavation of all areas within 100 feet of the site to a depth of 4 feet. The AO requires excavation of sediments greater than 1 ppm. The USEPA and the design team recognized the need to develop an ESD to resolve this conflict early in the design phase. Sediment data collection during the PDI was designed, in part, to help resolve this inconsistency.

4.3.1 Selected ROD Remedy

Section IX.A.3 of the ROD states, "Sediments within 100 feet of the Metal Bank property and within four feet of the surface of the river bed shall be excavated. Sediments beyond 100 feet of the Metal Bank property which have PCB concentrations exceeding 1 ppm shall be excavated if EPA determines during remedial design that such removal would be appropriate and feasible." Implementation of the ROD remedy will result in the excavation of many locations that testing has shown do not contain PCBs above the action level and for which excavation is unnecessary.

4.3.2 Basis for Remedy Explanation of Significant Difference

Data collected during the RI demonstrated that PCB contamination is greatest nearest the property and decreases into the river and mudflats. Much of the sediment with PCB levels above 1 ppm is within 100 feet of the property. The data also show that contamination extends to 4 feet below the river bed in some areas. Consequently, excavating to 4 feet would allow for the removal of those areas. Those same data also show there are significant areas within 100 feet of the site with PCB levels below 1 ppm or not detected as well as areas where contamination above 1 ppm does not extend below 2 feet. Defining the zone of remediation based on geometry will remove significant portions of the sediment with PCB levels above the recommended cleanup level of 1 ppm; however, it will also remove significant quantities of sediment that are well below the 1-ppm criteria. Leaving sediment with PCB concentrations above 1 ppm more than 100 feet from the site may leave in the river significant quantities of sediment above the recommended cleanup level.

The AO, Section III.E.4.a, states that "... sediment with PCB concentrations greater than 1 ppm shall be excavated." Based on the RI data, this specific direction will result in a remedy significantly different from that specified in the ROD.

Sediment data were collected during the PDI to further delineate the areas with PCB levels above the cleanup level. These new data show a distribution of sediments above the recommended cleanup level similar to the distribution seen in the RI data. Implementing the sediment remediation based on the AO criteria will result in the removal of more sediments that exceed the recommended PCB cleanup levels, while leaving those below the cleanup level undisturbed.

4.3.3 Description of Significant Difference to ROD Remedy

The proposed modification will be to design the sediment excavation to include those areas where PCB levels have been determined to be above the 1 ppm cleanup criteria. Areas with levels below the cleanup criteria will not be excavated. This modification will result in the removal of more contaminated sediments.

The area in front of the storm sewer and an area to the southeast of the site in the Delaware River do not exhibit contamination above 1 ppm and need not be excavated. The area in front of the storm sewer was found to contain very little, if any, sediment. Due to the cobbles, riprap, and rock that composed the surface in this area, samples could not be collected more than 6 inches below the surface. The area along the Delaware River in front of the site also was found not to have contamination above 1 ppm.

Sampling during the PDI also found that, in some areas, contamination above 1 ppm existed more than 100 feet from the site. Adding these areas to the excavation area is more appropriate than the excavation identified in the ROD. The flexible barriers for control of sediment proposed in the following two technology alternatives can be designed around the shape of the required areas of excavation. Section 3.13 provides a more detailed discussion of the specific areas proposed for excavation. This alternative will result in a moderate cost savings.

4.4 Elimination of Need for Dewatering

The ROD was developed when much of the experience with contaminated sediment remediation was limited to highly contaminated sediments that were excavated from behind a cofferdam after the excavation area had been dewatered. Geotechnical data in the Delaware River at the site had not been collected when the ROD was developed and no elutriate data were available. The feasibility of constructing a cofferdam had not been evaluated at the time of the ROD. The need for dewatering and treatment also had not been fully evaluated.

Techniques for sediment remediation have progressed since the ROD was developed, and site-specific data are available to better evaluate the feasibility and appropriateness of requiring dewatering.

4.4.1 Selected ROD Remedy

Section IX.A.4 of the ROD states, "Prior to excavation of soil or sediment, temporary cofferdams shall be installed at the outer edge of the sediment excavation boundary to dewater the sediment area so excavation can be accomplished."

4.4.2 Basis for Remedy Explanation of Significant Difference

Geotechnical data acquired in the Delaware River during the PDI show that the temporary cofferdams envisioned in the ROD cannot be installed. Because of the relatively thick layer of poorly consolidated silts and clays overlying thin sands and gravels as well as shallow bedrock elevations, pile embedment depths will be significantly limited. The structures as envisioned in the ROD will not be stable. Significantly more massive structures are required and construction of these large civil works will have a significantly greater negative impact on the river.

In order to install a cofferdam that would allow dewatering of the area behind, a cellular cofferdam would be required. The cellular cofferdam required would be a massive cellular structure with interlocking steel sheets forming individual cells approximately 30 to 50 feet in width. The individual cells would then be filled with fill material to create a gravity-anchored structure to withstand the potential water pressure during flood stages. Installation of this large structure would take 6 to 12 months and is inappropriate for the limited volume of required sediment excavation, which can be performed in 6 to 12 weeks.

Dewatering of the excavation and treatment of the large volume of water to NPDES standards would require a massive treatment system. Recently acquired geotechnical data indicate that the recharge of water into the area behind a cofferdam would require a massive and unnecessary dewatering effort. These efforts would be significantly greater than envisioned in the ROD and will have a greater negative impact on the river and surrounding area. The construction of the cellular cofferdam will effectively eliminate the aquatic environment behind the cofferdam during the significantly longer construction process and have a much more significant impact on the environment in the Delaware River at the site.

Elutriate data collected during the PDI show no PCBs in the elutriate water and minimal PCBs in the elutriate sediment. These data, which were not available when the ROD was developed, indicate excavation through the water column will not have a significant adverse impact on the surrounding environment. Contaminated sediment excavation is now routinely and more effectively achieved without dewatering. Excavation with a closed clamshell bucket or other low-impact excavation equipment positioned on the site or a barge will minimize the turbidity and any potential offsite migration of PCB-contaminated sediment.

4.4.3 Description of Significant Difference to ROD Remedy

The proposed ESD will allow the excavation of the sediments without dewatering the area of excavation. Low-impact excavation procedures used successfully for other sediment remediations will be specified. Information regarding the proposed alternate method of excavation is included in Appendix 6, Dredging Equipment Information. This modification will allow for quicker implementation of the remedy with less construction impact to the Delaware River. It will also make removal of contaminated sediments that have been identified in the areas farthest from the site more feasible. Ogden and Hart Crowser propose to design the excavation of the sediments without dewatering the excavation. Information regarding the proposed alternate method of excavation is included in Appendix 6, Dredging

Equipment Information. This alternative, combined with the next alternative, is expected to result in a several million dollar cost savings.

4.5 Containment of Suspended Solids with Turbidity Curtain

As discussed in the preceding section, the cofferdam was included in the ROD to allow the excavation of sediments with dewatering and to prevent the migration of contamination into the Delaware River during the excavation and backfilling. This goal may be achieved using other control technologies such as turbidity curtains with environmental dredging techniques without the cofferdam. A turbidity curtain is a much less disruptive technology that can easily be designed and shaped around the irregular areas requiring excavation. This technique has been successfully used at recent sediment remediations. At the time of the ROD development, successful examples of the use of this technique were not as numerous and had not been highlighted in the remedial literature.

4.5.1 Selected ROD Remedy

Although the ROD does not specifically address a procedure to prevent the migration of contaminants into the Delaware River during sediment excavation, Section IX.A.4 of the ROD implies the cofferdam will achieve this objective. Other remedy sections of the ROD address the handling of sediments and soils in the upland areas following excavation.

4.5.2 Basis for Remedy Explanation of Significant Difference

Installation in the depth of water required to remove 1 ppm could not be achieved with the sheet pile cofferdam anticipated in the ROD. Geotechnical data collected during the PDI, as discussed in the preceding section, confirm this. The cofferdam in the ROD is not necessary for turbidity control during sediment excavation. Properly engineered and installed turbidity curtains will protect the environment from the release or migration of PCB contamination.

Section 3.13.5 discusses potential approaches in greater detail. When used in conjunction with the low-impact excavation techniques proposed, turbidity curtains will be redundantly protective of the river environment.

Elutriate testing during the PDI showed that any PCB contamination associated with suspended sediment will be minimal. The redundant procedures proposed to contain this minimally contaminated sediment will be more protective of the river environment than installation of a sheet pile wall and will have less of an adverse impact.

As discussed in Section 4.3, areas more than 100 feet from the site with PCB levels above 1 ppm are proposed to be included within the zone of excavation. These areas can be included if turbidity curtains are used. It may not be feasible to include all of these areas if a fixed cofferdam must be installed. As discussed above, embedment depths are limited and may be insufficient in deeper water even if the excavation area is not dewatered.

4.5.3 Description of Significant Difference to ROD Remedy

A turbidity curtain that can be shaped around the limits requiring excavation will be installed to further control the potential for contaminant migration away from the excavation area. The turbidity curtain will be engineered for this Delaware River application. The design will account for the fluctuations in water level, changes in the river currents due to the tide, and changes in river currents due to extreme events. Boat- and wind-generated waves will be evaluated. Other factors such as overflows of the combined sewer, recreational boating in the vicinity of the site, debris or ice in the water, and construction egress will be considered in the design of the turbidity curtain system. Information regarding two turbidity curtain manufacturers that are currently being considered is included in Appendix 7, Turbidity Curtain Information.

This ESD will allow for a faster implementation of the sediment remediation with less construction impact to the Delaware River. Because it will be more feasible to remediate those areas farther from the property, more contaminated sediments will be excavated if this modification is approved.

Ogden and Hart Crowser propose to research and design a turbidity curtain that can be shaped around the limits requiring excavation. The turbidity curtain will be designed for the Delaware River application and will account for the fluctuations in water level and the changes in the river currents due to the tide. Historical tide and current will be accounted for in the design.

4.6 Elimination of Soil Monitoring Program

Groundwater at the Metal Bank site has been determined by the USEPA to contain contaminants that have the potential to migrate to surface soils during flooding events. The ROD calls for monitoring the clean soil cover placed over the site after subsurface soil excavation for evidence of any such upward migration of contaminants. Such monitoring may be eliminated if a geotextile membrane is installed beneath the soil cover. Ogden and Hart Crowser have not discussed this proposed alternative with EPA previously.

4.6.1 Selected ROD Remedy

Section IX.G.1 of the ROD states that "a soil monitoring program shall be developed during the Remedial Design to monitor the soil cover for evidence of the upward migration of contaminants in the groundwater cause[d] by flooding conditions that may raise the water table."

4.6.2 Basis for Remedy Explanation of Significant Difference

As discussed earlier, after the areas in the Southern Portion of the site that will have been excavated are properly graded, a lightweight geotextile will be placed over the graded material

to serve as a marker between the site soils and cover soils. The geotextile will be used to provide a uniform consistent barrier as opposed to the marking tape specified in the ROD. The geotextile also will allow for verification of the 2-foot soil thickness and will prevent the mixing of site soils with cover soils. The geotextile will prevent the migration of fines during flood conditions and will eliminate the potential upward migration of PCB contamination attached to soil particles. Therefore, the geotextile will eliminate the need for the soil monitoring program provided for in the ROD.

4.6.3 Description of Significant Difference to ROD Remedy

Ogden and Hart Crowser propose to install beneath the soil cover in the Southern Area a geotextile layer, which will serve as an effective barrier between site soils and clean cover soils, and thereby to eliminate the requirement for post-excavation monitoring of the clean soil cover. This alternative is not expected to result in any significant cost savings, but presents a better approach to construction.

4.7 Alternative Selection Summary

Ogden and Hart Crowser believe these proposed modifications are consistent with and accomplish the remedial goals of the ROD. These alternatives are also intended to reduce the impacts of construction on the environment. These alternatives will decrease the duration of construction while providing a more permanent solution that will require a minimum of long-term operation and maintenance. These alternatives also use the best available technology for this application. In summary, Ogden and Hart Crowser request that the USEPA approve the following alternatives with the review of this Preliminary Design:

Ogden Environmental and Energy Services Co., Inc./ Hart Crowser, Inc.

- Excavation instead of oil collection system.
- Optimization of the sheet pile wall.
- Excavation of sediments based on 1-ppm action level.
- Elimination of the need for dewatering.
- Containment of suspended solids with a turbidity curtain.
- Elimination of soil monitoring program.

5.0 CONSTRUCTION SEQUENCE AND SCHEDULE

This section includes a discussion of the sequence of construction and a preliminary schedule for the remedial action. This construction sequence and schedule will be further developed as the design process continues and is intended to help develop an understanding of the overall comprehensive design package.

5.1 Pre-Construction Activities

Prior to construction, the Contractor will be required to provide the submittals and work plans required by the specifications. These work plans will include the submission of a chemical and biological monitoring plan for the Delaware River. The submission of any other construction work plans and submittals required prior to construction will also be included. Subcontractor qualifications will be required to be submitted for USEPA approval prior to any subcontract work onsite.

5.2 Mobilization

The first element of construction will be mobilization. Mobilization will include establishment of the Engineer's and Contractor's office trailers as well as preliminary access and control facilities. Once mobilization is completed, the preliminary elements of construction will include the installation of the inland portions of the perimeter security fence and the establishment of perimeter sediment and erosion controls.

The next stage of construction will include the construction of water management facilities and the construction of the soil stockpile area. These construction activities will be performed while accessing the site through the existing gates to minimize traffic across contaminated soils in the Courtyard Area.

5.3 Upland Area Construction Sequence

Once these steps are established, the Courtyard soil excavation will proceed. The Courtyard soil excavation will be followed by the decontamination pad construction, backfilling of the excavation, and installation of the 12 inches of cover soil in the Courtyard Area. This process will complete the Courtyard Area activities and isolate any potential PCB contamination below 10 ppm prior to construction traffic in this area. The construction access road construction will then proceed.

Once these areas are established, the sheet pile wall will be installed in the Southern Area. Any necessary clearing and grubbing in the Southern Area and demolition will proceed next and concurrent with excavation of Areas SA-1 to SA-3. The UST closure and the excavation of soil in Area SA-4/5 will be the final excavation activities. As excavation occurs, the smaller excavation areas in the Southern Area could be filled with any excavated soil that was excavated to remove soil greater than 25 ppm, but stockpiled and tested to be below 25 ppm.

Excavation activities will proceed until the completion of the SA-4/5 excavation and the removal of any LNAPL that is encountered. The larger excavation will be backfilled with sediments excavated from the Delaware River. Sediment excavated from the Delaware River will be placed in the bottom of the excavations in approximate 12-inch controlled lifts. The broken concrete pile will then be placed in alternating lifts within the excavation. Additional concrete from the soil stockpile area will also be allowed to be placed within the excavation once soil disposal activities are complete.

After the excavations are backfilled, any additional sediment will be graded on the site to create the preparatory grades required prior to installation of the 2-foot soil cover. Once the preparatory grading is complete, the geotextile will be installed, the cover soil will be placed, and the site will be vegetated.

5.4 River Area Construction Sequence

During the excavation of the Southern Area soil, the turbidity controls will be installed in the Delaware River. The intended construction sequence is to begin sediment excavation as soon as the Southern Area excavation activities are complete. Sediment excavation activities will then proceed down river and in towards the shore. Once excavation is complete, the soil cap will be installed in the excavated areas. Once the excavations are backfilled, the turbidity controls will be removed.

5.5 Post-Construction Activities

When the site construction activities are completed, demobilization will occur. As part of demobilization, as-built drawings will be prepared and a final construction report will be provided to the USEPA. At the completion of demobilization, the ongoing monitoring programs will continue until no longer required.

5.6 Construction Schedule

In accordance with Section VI.C.2.a.(6) of the AO, Ogden has prepared a preliminary schedule for the construction activities. The schedule, included as Figure 6, is based on the anticipated construction sequence developed in this section. The schedule was developed using Microsoft Project, Version 4.0, and will be revised to include additional detail and subtasks as design progresses.

6.0 SUMMARY OF PRELIMINARY DESIGN

To provide a sound basis for preparation of the attached design, Ogden has performed and will be performing regulatory reviews, product evaluations, industry standards reviews, design parameter analyses, and peer reviews. The drawings and specifications define the construction product. Project reviews have been performed throughout this design process to try to maintain quality control and to assure continuous communication with the USEPA in order to provide a deliverable that is in alignment with the USEPA's expectations.

6.1 Preliminary Design Submittal

The Preliminary Design submittal includes preliminary or conceptual construction drawings and specifications for the Remedial Design at the Metal Bank Superfund site. The Preliminary Design package includes a design report with a description of how the design will be developed and the process for the design, as well as the construction drawings available at the 30-percent design phase, and an outline of the specifications for the project. Based on the findings of the PDI, it is also appropriate to revise the ROD remedy to incorporate approaches to the work that will achieve the goals and objectives of the ROD with an improved approach.

Early in the design process, Ogden performed a regulatory review. Any discovered requirements were incorporated into the design. The appropriate local agencies will be contacted during the future design to determine if anything was omitted in the previous evaluation. Any resulting changes will be incorporated into the design.

As the Preliminary Design was being performed, Ogden reviewed the ROD remedy and the technologies selected for the remedial action. Ogden also performed a cost and schedule analysis and evaluation of the ROD remedy to determine if there is a more appropriate approach to meet the goals and objectives of the ROD, while reducing the time and cost required to complete the project and the impact of the project on the environment. Ogden and Hart Crowser were also

interested in minimizing long-term operation and maintenance of the system and increasing the permanence of the designed remedial action.

6.2 Preliminary Design Report

The Preliminary Design submittal includes a Design Report of the system design with backup information, including vendor cut sheets and other information required to demonstrate the acceptability of the design elements that are being proposed for the 30-percent phase of the design process. The Design Report includes a description of the design elements and their relationship to the overall design. Backup information includes manufacturers' equipment cut sheets and product information; calculations of design parameters will be supplemented with the future design deliverables. The field investigative data that also provided a basis for the design document were provided with the PDI Report submitted to the USEPA dated January 21, 2000.

The Preliminary Design Report describes the basis of the project design and discusses how the proposed design meets the cleanup objectives. Future design deliverables will include calculations for specific components of the design and additional assumptions used in developing the project design. The Preliminary Design Report is intended to be a brief document describing the major components of the design and justifying the proposed technologies and approach to the remedial action with the understanding that the approach, once accepted, will be refined during the future design.

6.3 Preliminary Design Drawings

Preliminary design drawings include the site drawings for the remedial action construction contract. The preliminary drawings present the layout of the project facilities showing location, dimensions, and alignment of components. Drawings are prepared to show the site, foundation plans, storage facilities, remediation actions, and remedial limits and details necessary to define and demonstrate the intended construction approach. Sizing of equipment and details will be shown on the plans. The drawings are divided into four divisions, which include "T" or title

drawing; "S" or site plans drawings; "C" or civil engineering drawings; and "M" or mechanical engineering drawings. The drawings were developed on AutoCAD, Version 14[®] and will be prepared on "D" sized sheets (24 x 36 inches), but have been reduced for inclusion in this report.

6.4 Preliminary Construction Specifications

Ogden will prepare preliminary construction specifications for the remedial action. The specifications will be based on the Construction Specification Institute format, which divides the project work into 17 divisions numbered from 00000 to 16000, and will include any required contract language provided by the USEPA. The specifications include all activities and components of the proposed work. At the 30-percent design phase, the specifications are in the development phase, and Appendix 1 includes the index of the specifications only.

6.5 Construction Cost Estimate

A construction cost estimate will be prepared on the basis of the remedial action approach that has been included with this design when the approach is accepted by the USEPA. This cost estimate will be submitted with the future design deliverables for information purposes only. As the design is further reviewed and developed, the cost estimate will be further developed and should become more accurate and detailed.

6.6 Future Design Deliverables

The Preliminary Design has been prepared to the 30-percent design level and is intended to propose the conceptual approach to construction, including the technologies and methods that will be utilized to achieve the goals and objectives of the ROD. The submittal is intended to provide the information necessary for the USEPA to approve these technologies and methods so that they can be more thoroughly developed during the remaining 70 percent of the Remedial Design.

After the USEPA has had the opportunity to review the Preliminary Design Report, Ogden would like to meet with the USEPA to discuss the design and any required changes to the methods and technologies requested or required by the USEPA.

The project drawings, specifications, and the engineering cost estimate are expected to be developed and improved in the intermediate and remaining design steps. Ogden will need to wait until the review by the USEPA is completed and the technologies and methods are approved or modified before the development of the next design deliverable can proceed. Before obtaining these approvals from the USEPA, Ogden will continue to develop the specifications, develop consistencies between sections, and further define components that may be referenced only in general terms.

During the final design phase, Ogden will prepare the project manuals for solicitation of competitive bids. The project manual will be a bid package prepared for the solicitation of Construction Services to construct the remedial action. With this submittal, Ogden has included only the index of the specification.

As the Preliminary Design was being performed, Ogden reviewed available technologies to determine the best approach to meet the ROD remedy goals. Ogden also performed a cost and schedule analysis of these components. The proposed design is believed to provide the most cost-effective and schedule-efficient components to provide a low maintenance and permanent solution to the Remedial Action.

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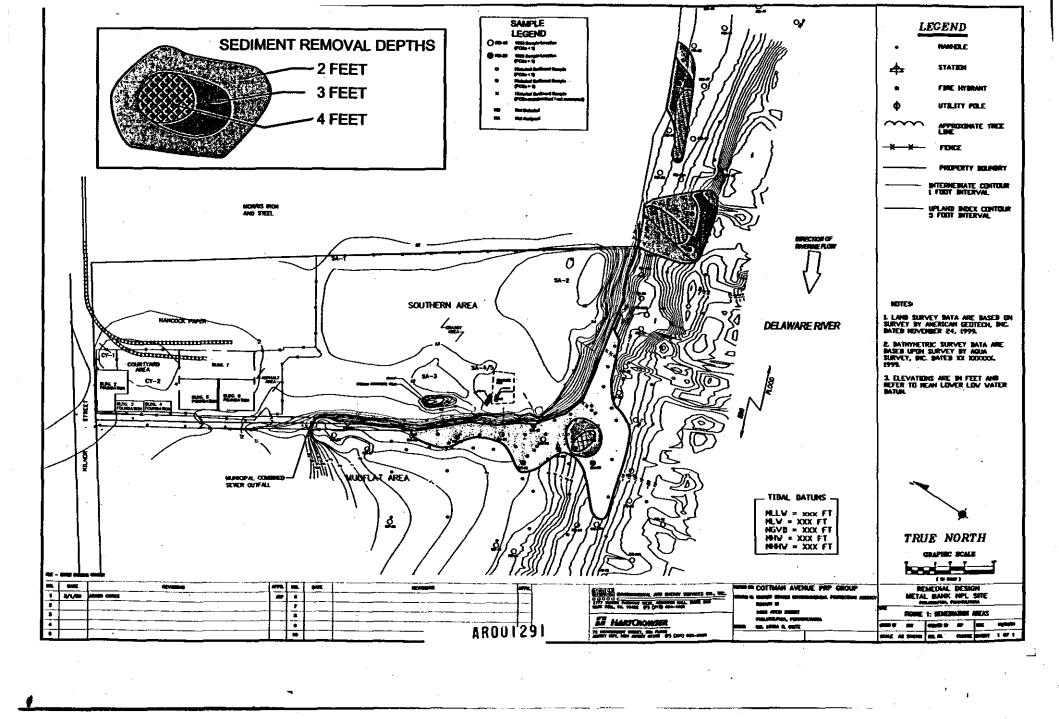
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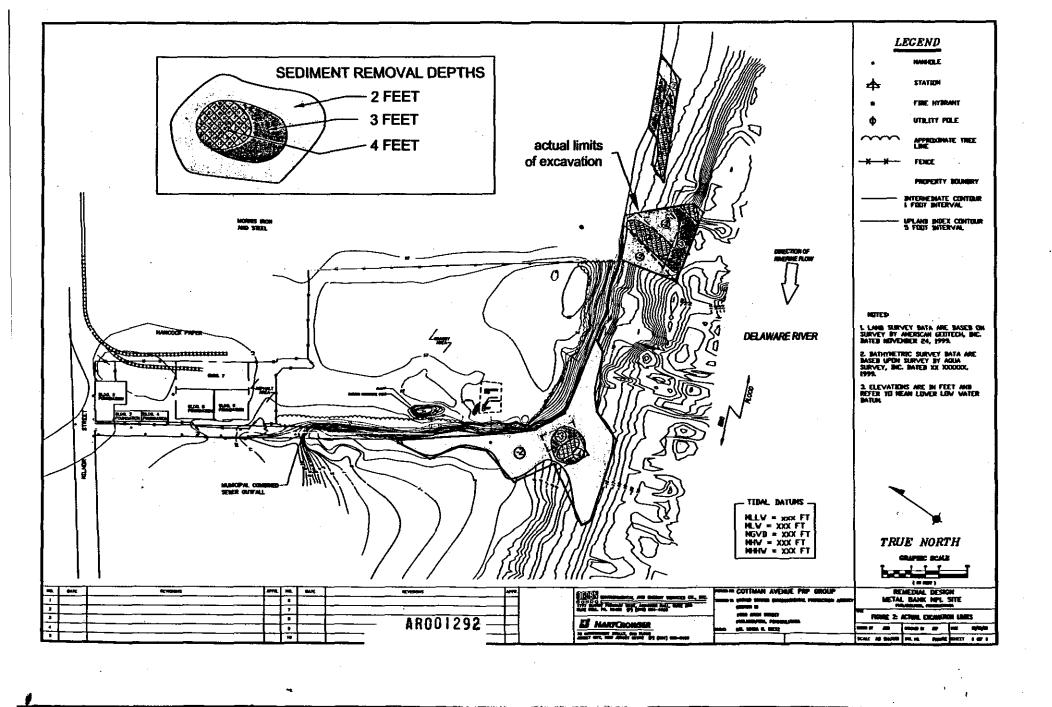
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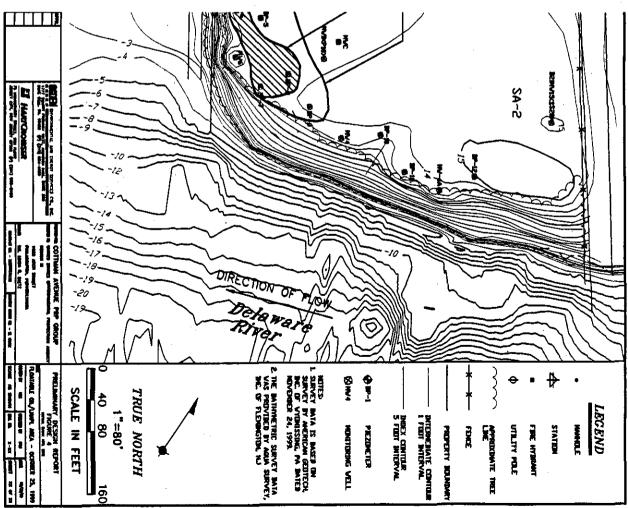
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TABLES

TABLE 1 METAL BANK COTTMAN AVENUE SITE POTENTIAL MODIFICATIONS TO ROD REMEDY

PREPARED BY COTTMAN AVENUE PRP GROUP AND OGDEN/HART CROWSER

	ROD REMEDY COMPONENT	Proposed Alternative	TECHNICAL/FACTUAL/ SCIENTIFIC JUSTIFICATION
1	Soils in the Southern Portion (ROD §§ IX.A.2, A.6, B.1)	Management of soils in- place, with appropriate containment and isolation of contaminated soils, in lieu of excavation is still under consideration.	Based on the results of the PDI, the extent of the excavation may increase significantly. Reasonable alternatives, which might include containment with a sheet pile wall (or slurry wall) and cap, should be considered. Once contained and isolated using alternative and applicable practices, the soils in the Southern Area will achieve the EPA goals.
. 2	Soils in the Courtyard Area (ROD §§ IX.A.1, A.6, B.1)	Placement of soils containing between 10 and 50 ppm PCBs in Southern Portion (assuming approval of Proposed Alternative 1).	25 to 50 ppm soil should be allowed to be placed in the Southern Area and capped if Alternative 1 is determined to be acceptable.
3	Capping of Southern Portion (ROD § IX.A.6)	Replacement of 24-inch cap with a 12-inch cap.	The ROD provides limited justification ("incidental recreation") for a 24-inch soil cap and requires a 12-inch cap in the Courtyard. Both areas should require a 12-inch cap as there is not a significant difference between the two areas. In addition, the PDI demonstrated the existence of a soil cap at the site with little or no surface contamination above 25 ppm.
4	Oil collection system (ROD § IX.C.2)	Design and installation based on extent of LNAPL is still under consideration.	The LNAPL collection system should be designed based on the extent of LNAPL and should address only the area and extent of LNAPL.
5	Sheet pile wall (ROD § IX.C.1)	Design and placement based on extent of LNAPL rather than entire southern and western perimeter is still under consideration.	The sheet pile wall system should be designed based on the extent of LNAPL and should address the area of LNAPL contamination.
6	Decontamination of oversized materials (ROD § IX.B.5)	Containment behind sheet pile wall instead of decontamination.	A sheet pile wall should be installed around the water perimeter of the site at the toe of the slope to make it acceptable to leave PCB-contaminated soils in the Southern Area. The wall would prevent erosion from the site, contain potentially contaminated rip-rap, and decrease the sediment excavation.

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TABLE 1 METAL BANK COTTMAN AVENUE SITE POTENTIAL MODIFICATIONS TO ROD REMEDY

PREPARED BY COTTMAN AVENUE PRP GROUP AND OGDEN/HART CROWSER

	ROD REMEDY COMPONENT	PROPOSED ALTERNATIVE	Technical/Factual/ Scientific Justification
7	Sediments within 100 feet of the site and 4 feet of the surface (ROD § IX.A.3)	Excavation only of areas and depths where PCB concentrations exceed 1 ppm and only where appropriate and feasible.	The ROD included significant areas where the sediments within 100 feet were tested to be below the 1-ppm action level. The 1-ppm action level should guide the delineation of zones for excavation. Placing more emphasis on current analytical data as opposed to dated test kit data is also appropriate because of the greater accuracy of the new data.
8	Dewatering of sediments prior to excavation (ROD § IX.A.4)	Elimination of dewatering and use instead of alternate technologies that will prevent releases during excavation.	The ROD requires dewatering the area behind the cofferdam and treating the water to NPDES standards. Contaminated sediment excavation is routinely achieved without dewatering. The elutriate data indicates dewatering is unnecessary.
9	Temporary cofferdams (ROD § IX.A.4)	Elimination of cofferdams and use instead of alternate technologies that will prevent releases during excavation.	The cofferdam was included in the ROD as a method to allow the excavation of sediments "in the dry" with dewatering and to prevent the spread of contamination into the Delaware River. This may be achieved using other control technologies, such as silt curtains and/or environmental dredging techniques, without the cofferdam. The elutriate data helps to justify this position.

APPENDIX 1

Index of Construction Specifications

APPENDIX 1

Index of Construction Specifications

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION 3 1650 ARCH STREET PHILADELPHIA, PENNSYLVANIA

BID DOCUMENTS

CONTRACT NO. XXXXXX REMEDIAL DESIGN PROJECT

METAL BANK NPL SITE COTTMAN AVENUE AND MILNOR STREET PHILADELPHIA, PENNSYLVANIA

ISSUED:	BID OPENING _	

SOIL REMEDIATION PROJECT METAL BANKS SITE

TECHNICAL SPECIFICATIONS

NUMBER	DESCRIPTION	PAGE
BIDDING REQ	UIREMENTS, CONTRACT FORMS, AND	CONDITIONS OF THE
CONTRACT	·	
00020	Invitation to Bid	
00021	Mandatory Pre-Bid Conference	
00101	Instructions to Bidders	
00200	Information Available To Bidders	
00312	Bid Form - Unit Price	
00400	Supplements to Bid Form	
00410	Rejection of Bid	
00501	Agreement	
00510	Termination	
00701	General Conditions	
00811	Supplementary Conditions	
DIVISION 1 -	GENERAL REQUIREMENTS	
01010	Summary of Work	
01014	Construction Sequence	
01025	Measurement and Payment	
01026	Schedule of Values	
01027	Application for Payment	
01039	Coordination and Meetings	
01050	Project Surveying	
01110	Environmental Protection Procedure	
01300	Submittals	
01350	Chemical Quality Management Plan	
01400	Quality Management Plan	
04.104		

01401

01410

01420

01501

01510

01590

Health and Safety

Decontamination

Field Offices

Temporary Utilities

Services

Testing and Testing Laboratory

Construction Water Management

1: 1

DIVISION 2 - SITE WORK

02060	Demolition
02065	Underground Storage Tank Closure
02110	Clearing and Grubbing
02210	Excavation, Backfill, Grading and
	Cover Soil
02223	Sub-Aqueous Cap
02240	Shoreline Protection
02250	Dredging
02270	Erosion and Sediment Pollution
	Control
02276	Turbidity Curtain
02369	Sheet Pile Wall
02750	Well Abandonment
02751	Monitoring Well Installation
02756	Chemical and Biological Monitoring
02831	Chain Link Fence and Gates
02910	Re-vegetation

Ogden Environmental and Energy Services Co., Inc./ Hart Crowser, Inc.

01564	Spill and Discharge Control
01600	Material and Equipment
01630	Product Options and Substitutions
01640	Offsite Transportation and Disposal
01700	Contract Closeout
01710	Mobilization/Demobilization
01720	Project Record Documents

DIVISION 2 – SITE WORK

02060	Demolition
02065	Underground Storage Tank Closure
02110	Clearing and Grubbing
02210	Excavation, Backfill, Grading and
	Cover Soil
02223	Sub-Aqueous Cap
02240	Shoreline Protection
02250	Dredging
02270	Erosion and Sediment Pollution Control
02276	Turbidity Curtain
02369	Sheet Pile Wall
02750	Well Abandonment
02751	Groundwater and Surface Water
	Monitoring
02756	Delaware River Monitoring
02831	Chain Link Fence and Gates
02910	Re-vegetation

APPENDIX 2

Preliminary Design Drawings

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION 3

REMEDIAL DESIGN METAL BANK NPL SITE

PHILADELPHIA, PENNSYLVANIA CONTRACT NO. XXXXXXXX

GENERAL DRAWING INDEX

TITLE		DWG. NO.	ISHEET NO
TITLE SHEET		T-1	1 OF 49
LOCATION AND VICINITY MAPS		3-1	2 OF 49
EXISTING SITE CONDITIONS		5-2	3 OF 49
HORIZONTAL/VERTICAL SURVEY CONTROL PLAN		5-3	4 OF 49
REMEDIATION PLAN		5-4	5 OF 49
EXISTING SITE CONDITIONS (MARINE SEDIMENTS)		S-5	6 OF 49
EROSION AND SEDMENT CONTROL PLAN		C-1	7 OF 49
DEMOLITION PLAN		C-2	8 OF 49
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CUT AND FILL CALCULATIONS SHEET	(TO BE PROVIDED)	C-10	16 OF 49
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ENOSION AND SEDMENT DETAILS AND SPECIFICATIONS		C-20	26 OF 49
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STORMWATER BETAILS AND SPECIFICATIONS	(TO BE PROVIDED)	C-22	28 OF 49
CIVIL DETAILS	(TO SE PROVIDED)	C-23	29 OF 49
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EXCAVATION SECTIONS		C-29	35 OF 40
TURBIDITY CONTROL PLAN		Ç-30	36 OF 49
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SEDMENT FINAL GRADING PLAN	(TO BE PROVIDED)	C-32	38 OF 49
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SHEET PILE WALL AND ANCHOR SYSTEM DETAILS		C-34	40 OF 49
TURBIDITY CONTROL PLAN BETAILS AND SPECIFICATIONS	(70 BE PROVIDED)	C-35	41 OF 49
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TURBIDITY CONTROL PLAN DETAILS AND SPECIFICATIONS	(10 DE PROVIDED)	C-37	45 OF 40
PREVIOUS SAMPLE LOCATIONS		C-38	44 OF 48
PREVIOUS SAMPLE LOCATION COORDINATES		C-39	45 OF 49
SUBSURFACE BORING LOCATIONS		C-40	46 OF 49
SUBSURFACE CROSS SECTIONS		C-41	47 OF 49
CONSTRUCTION WATER MANAGEMENT PLAN	(TO SE PROVIDED)	M-1	46 OF 49
CONSTRUCTION WATER TREATMENT BETAILS	(TO SE PROVIDED)	M-2	49 OF 49

PREPARED BY

(TO BE PROVIDED - INDICATES DRAWING WILL BE DEVELOPED WITH INTERMEDIATE DESIGN)

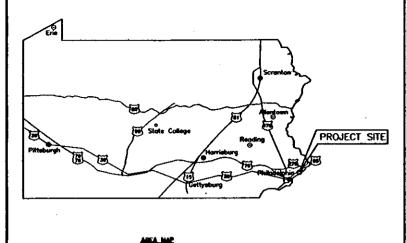
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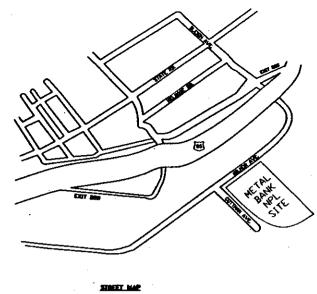
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75 MONTGOMERY STREET, 5TH FLOOR
JERSEY CITY, NEW JERSEY 07302 (P) (201) 985-8100

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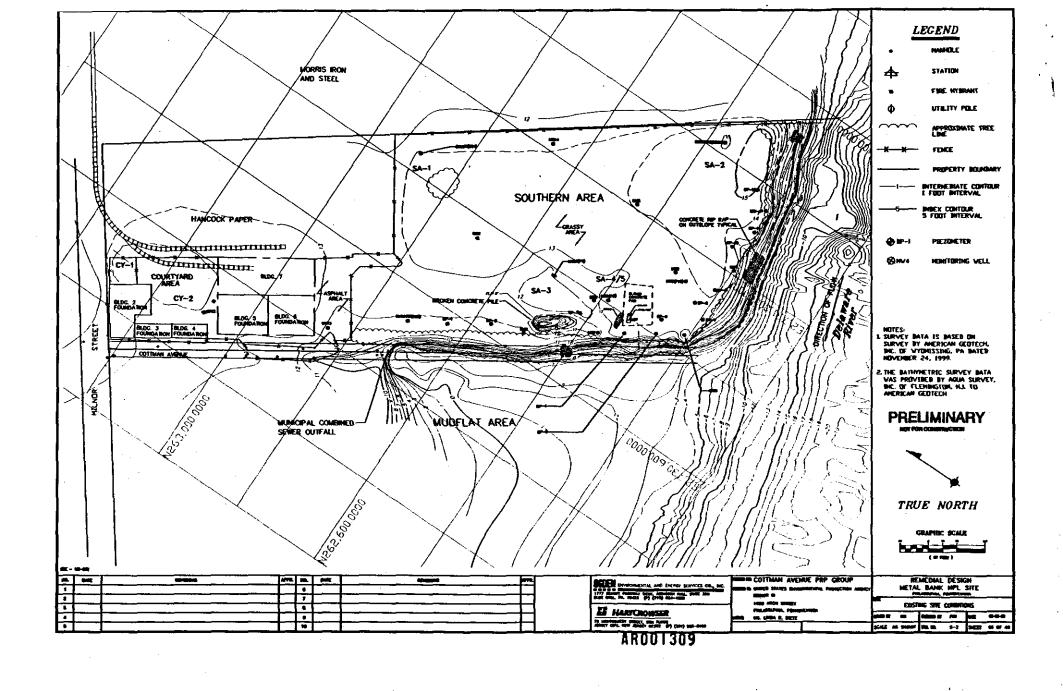
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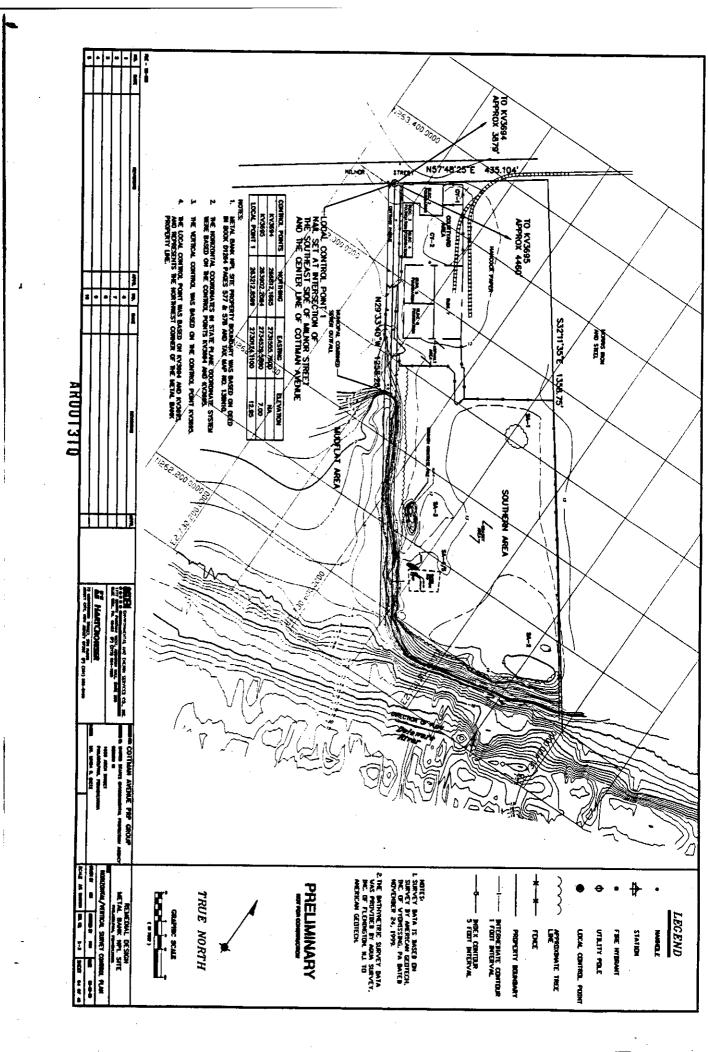
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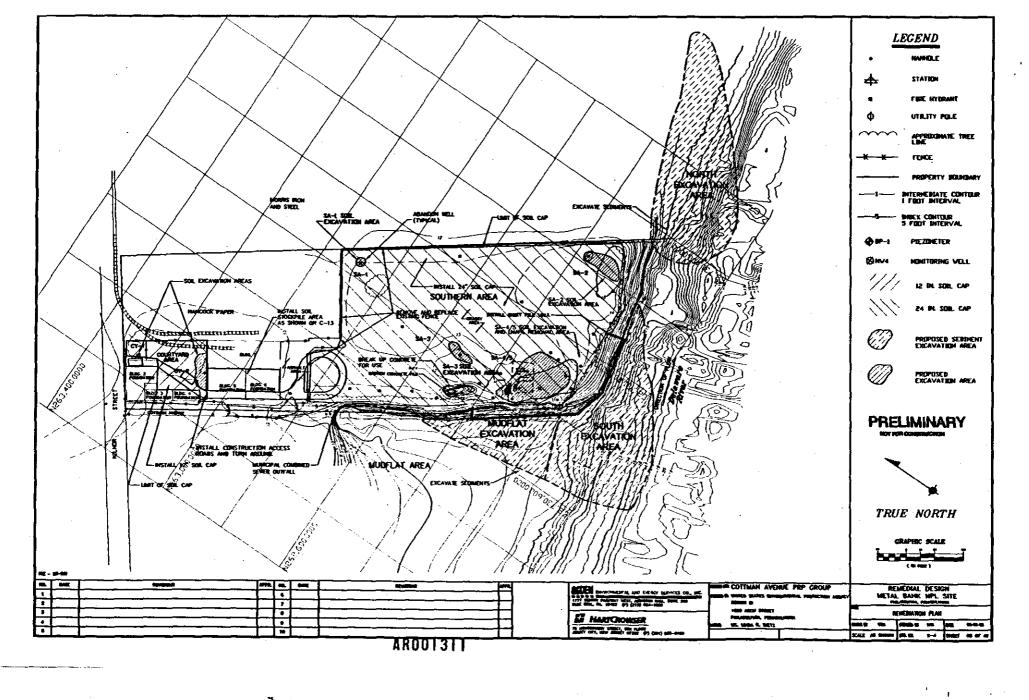
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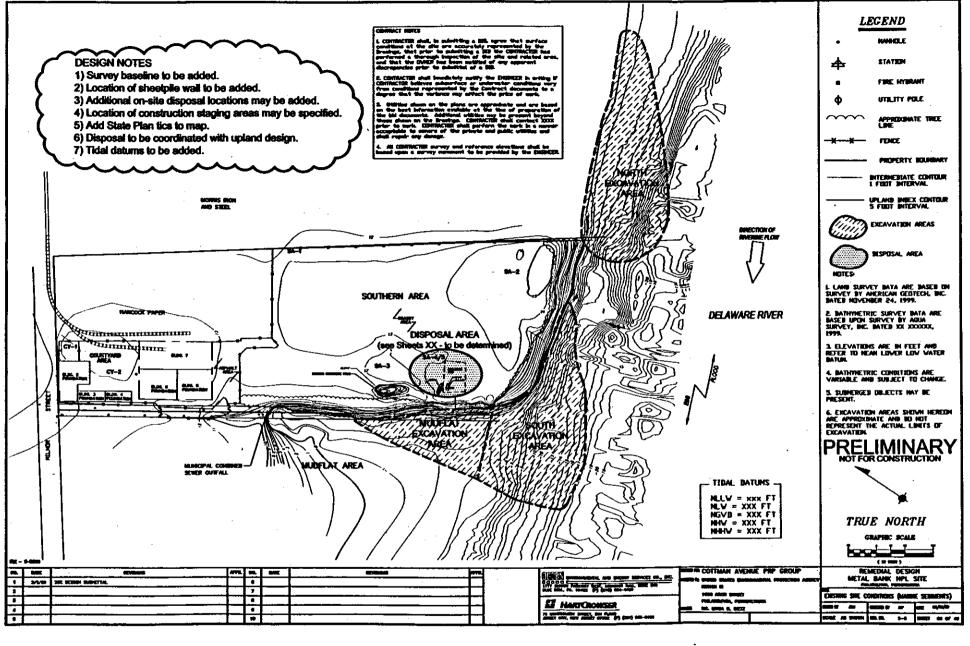


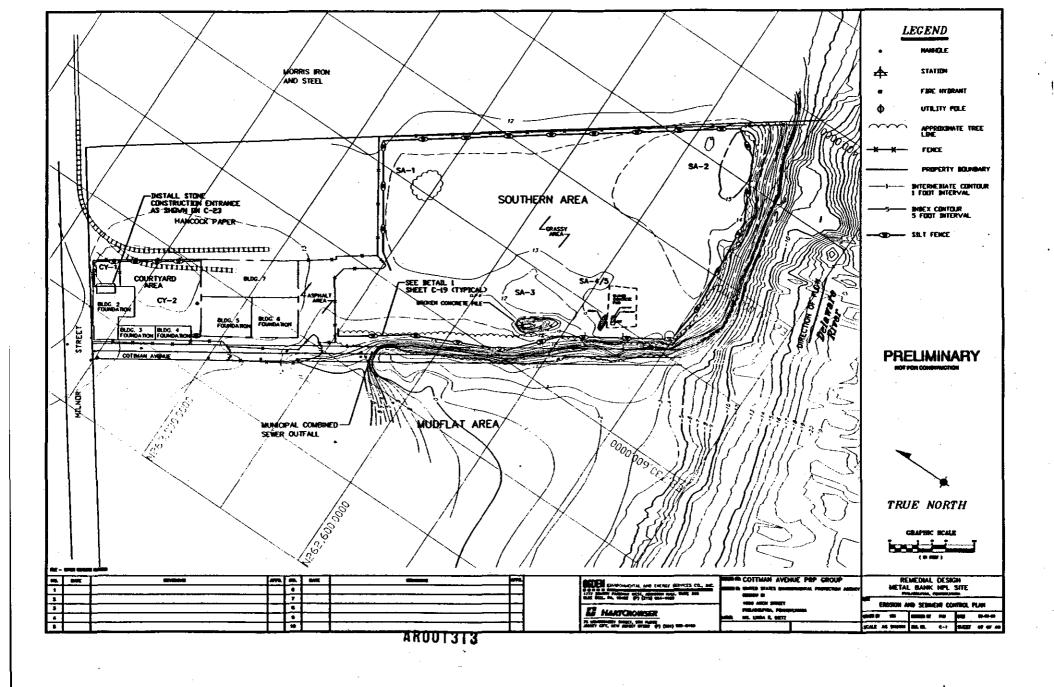


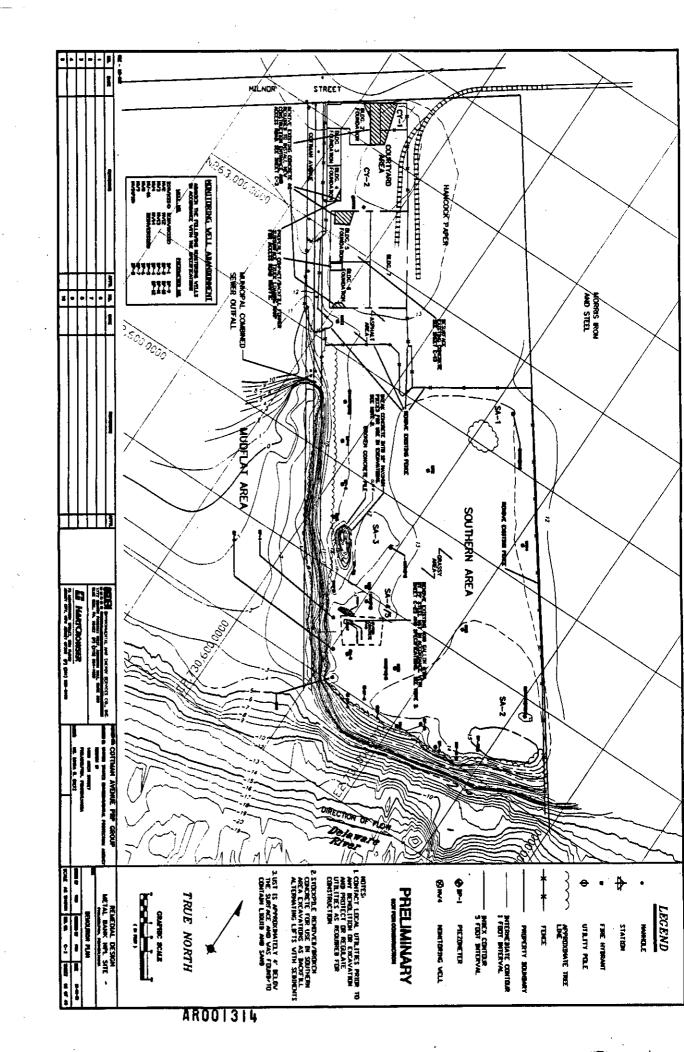


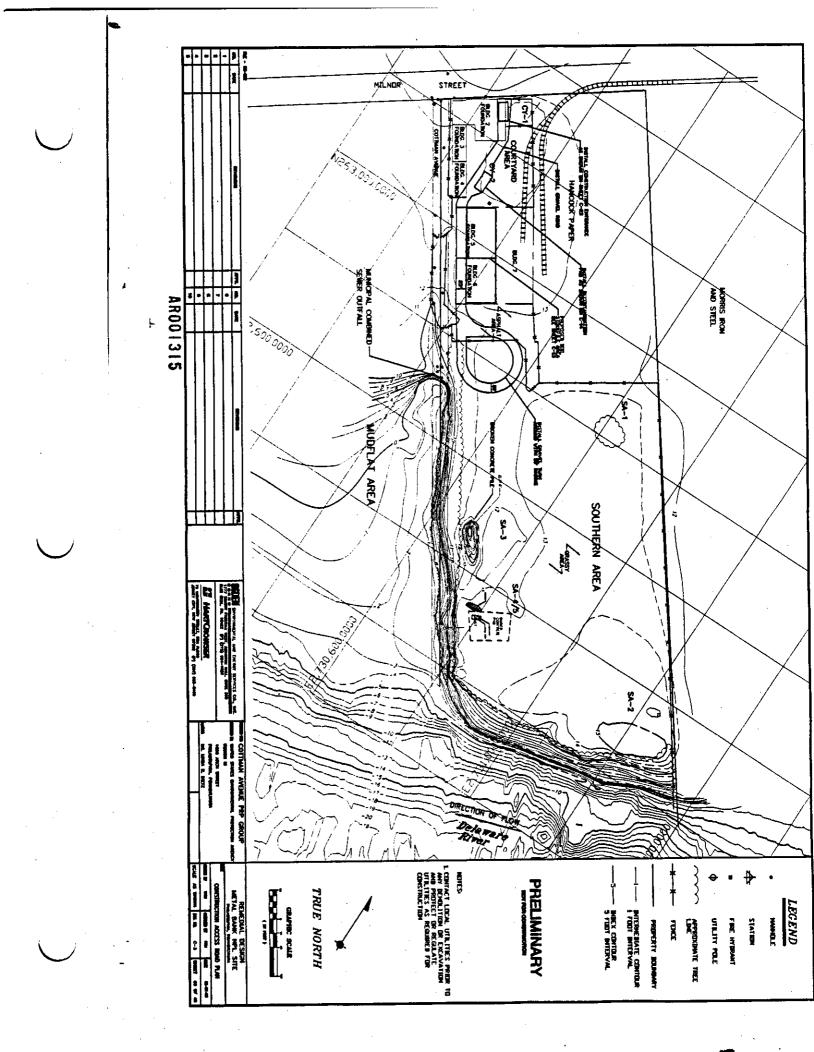
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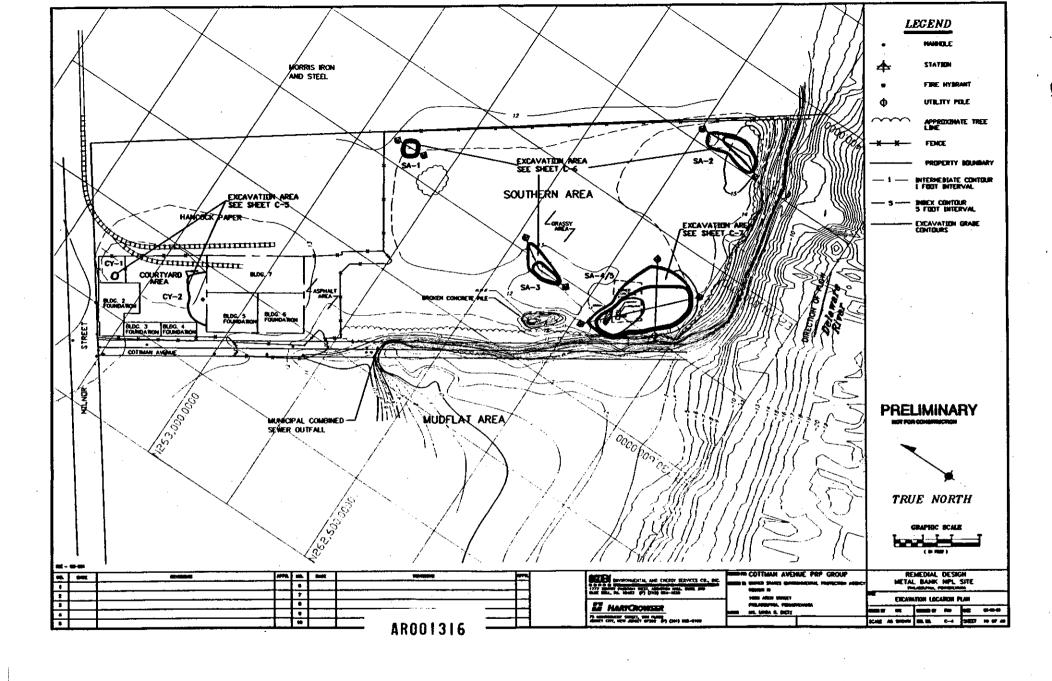


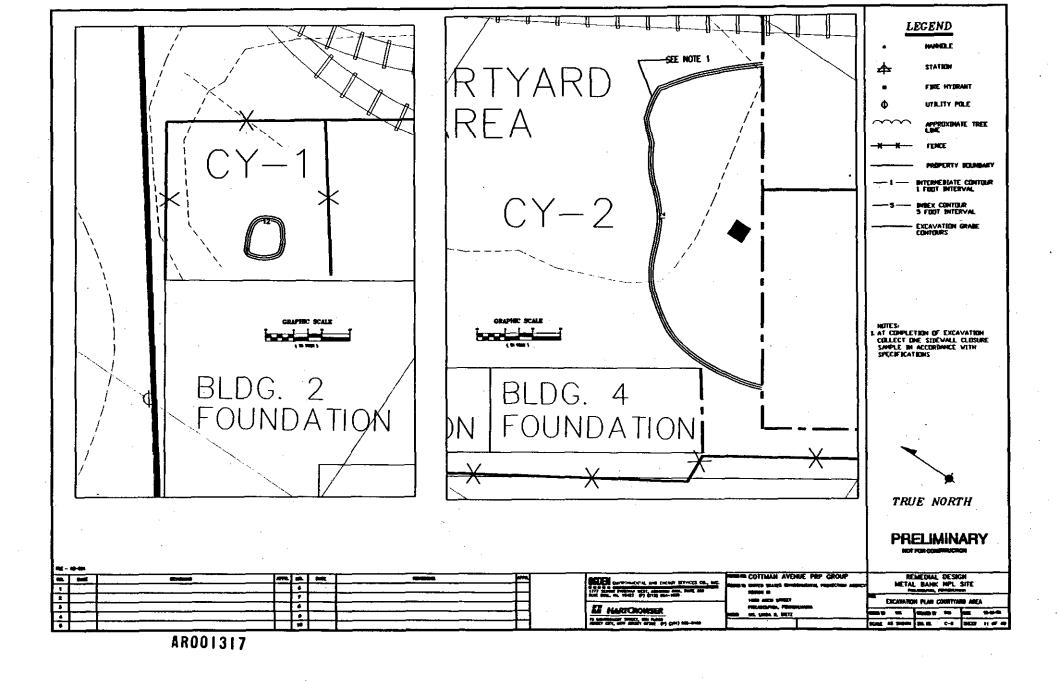


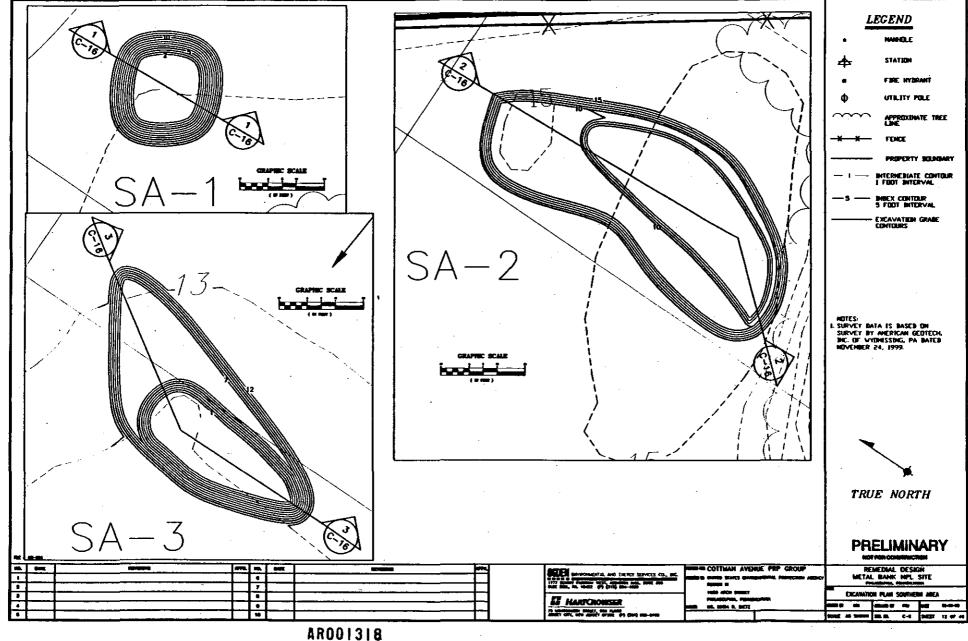


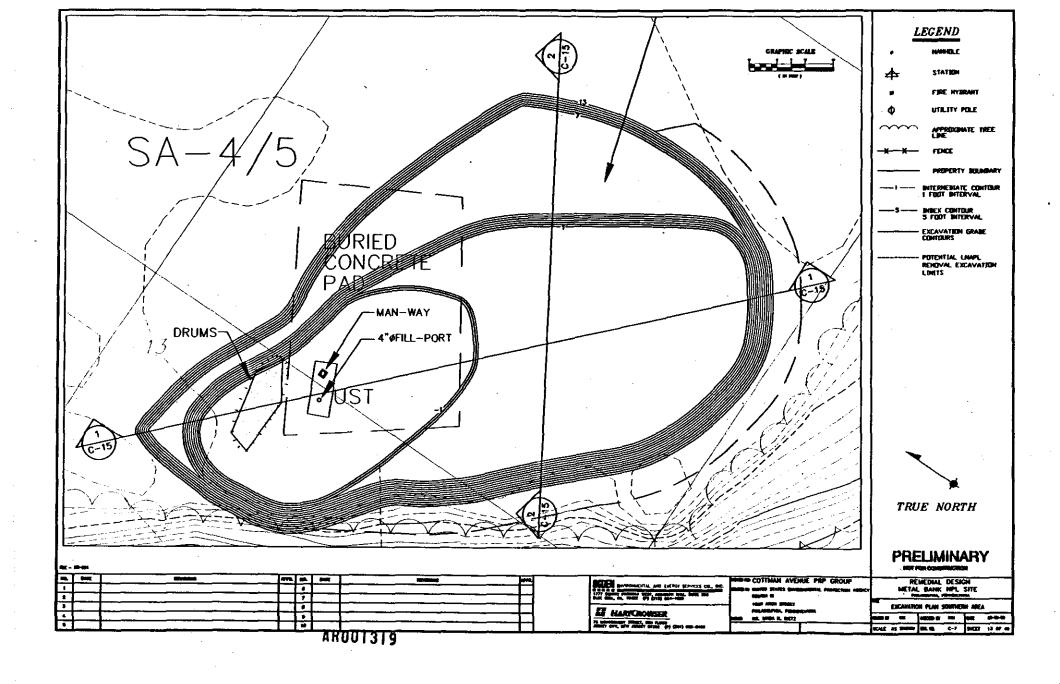


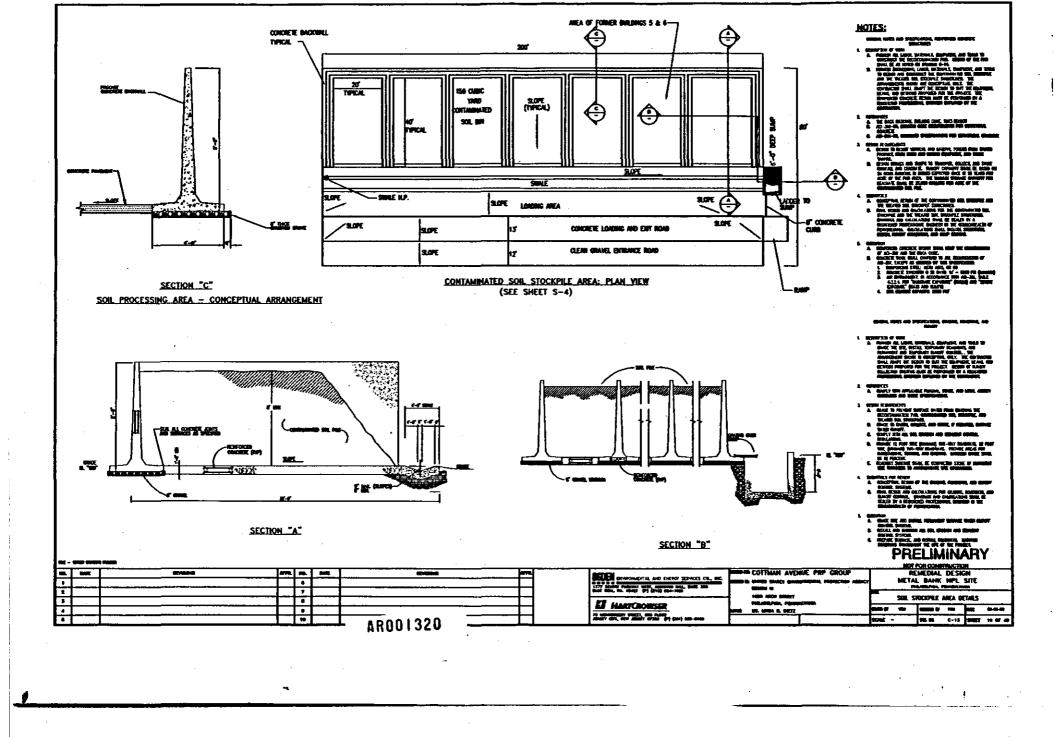


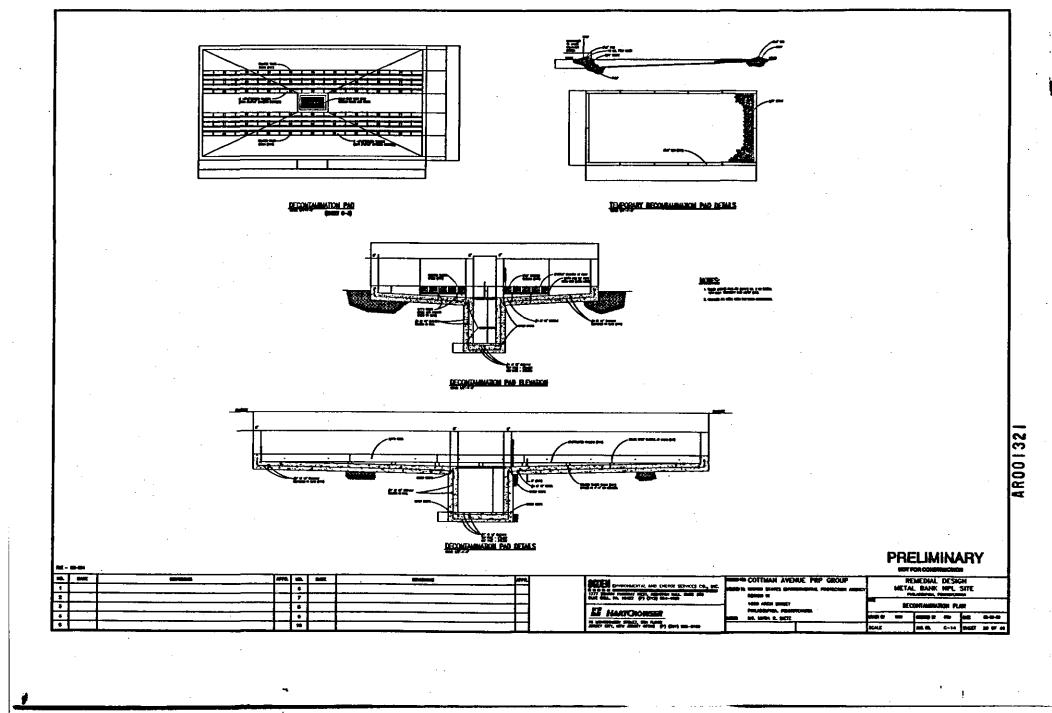




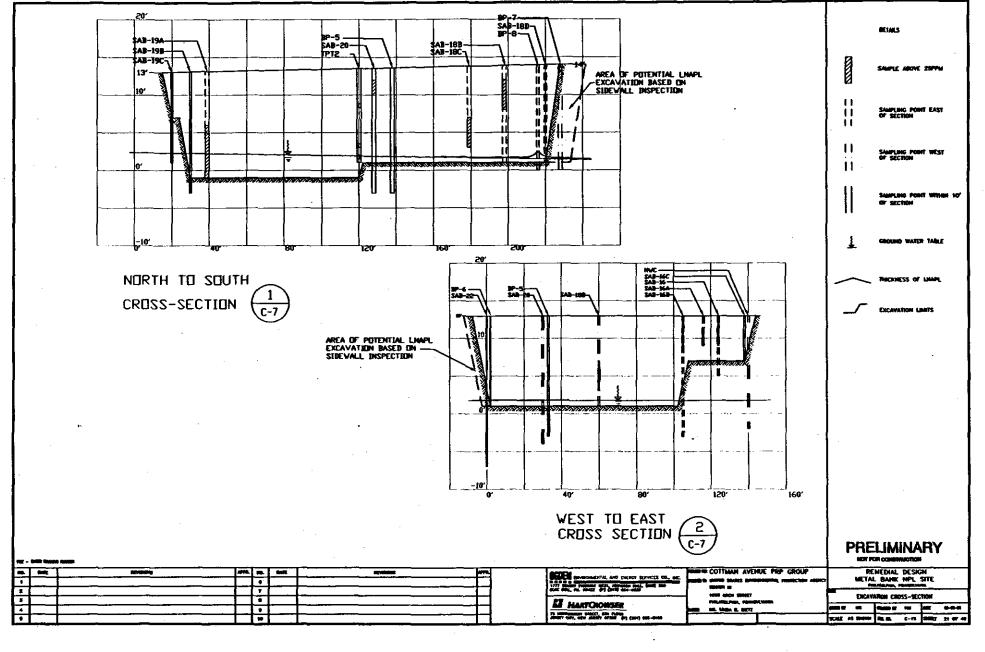


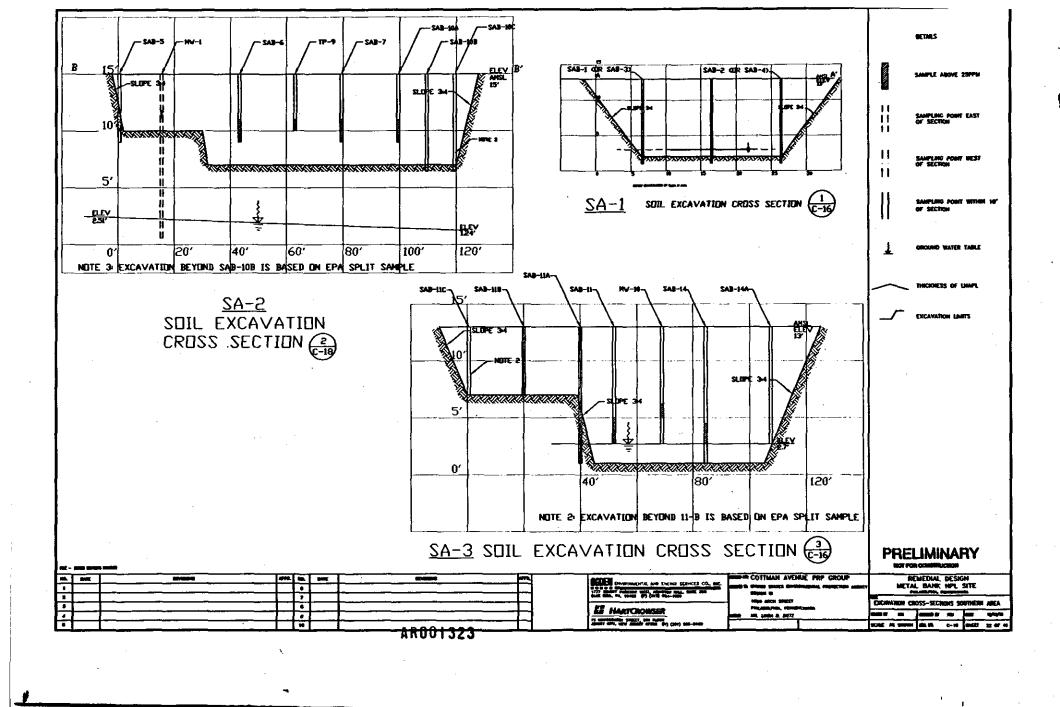




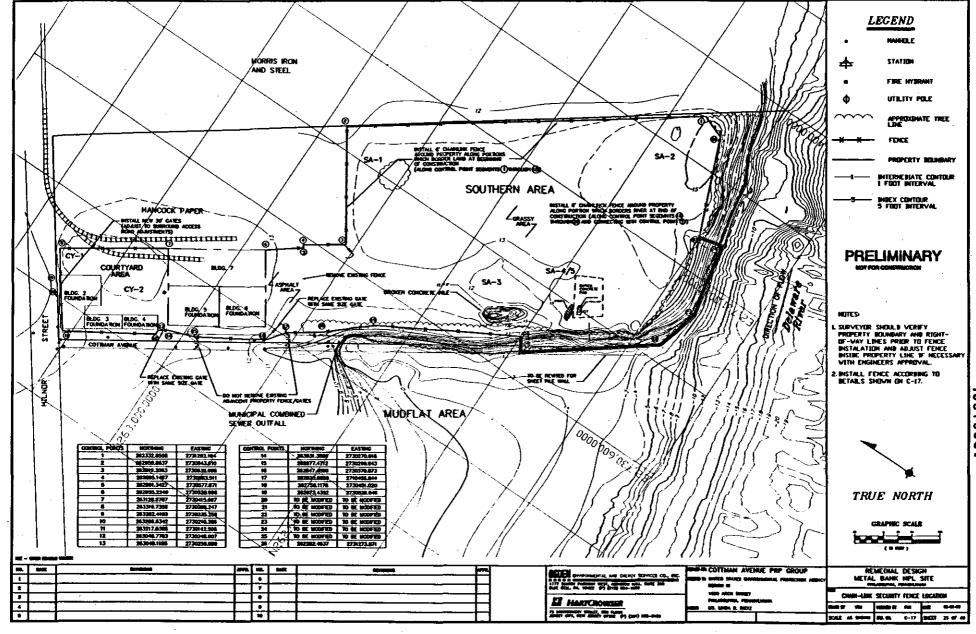


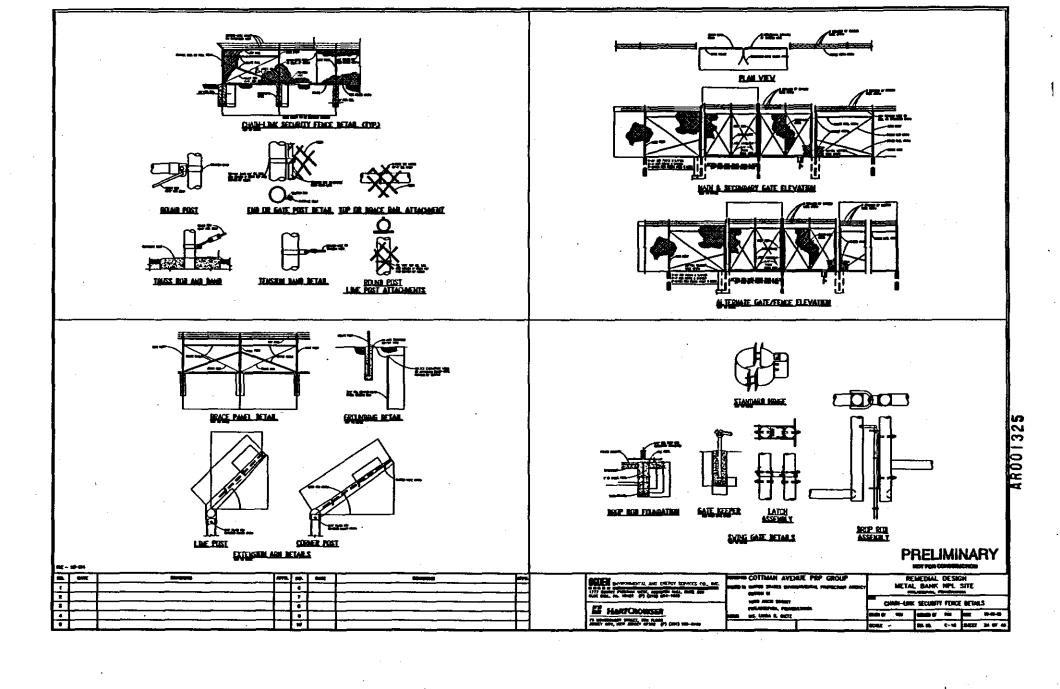


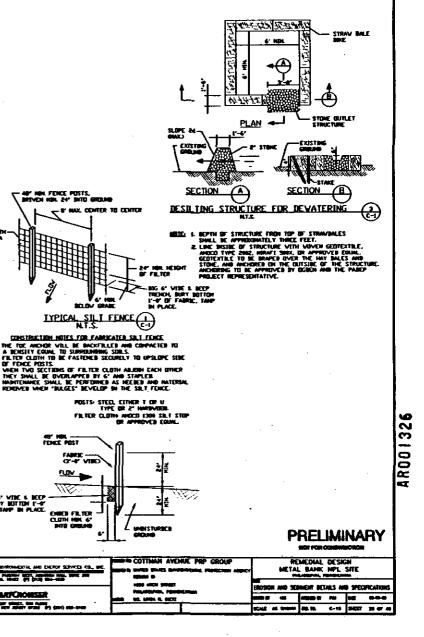


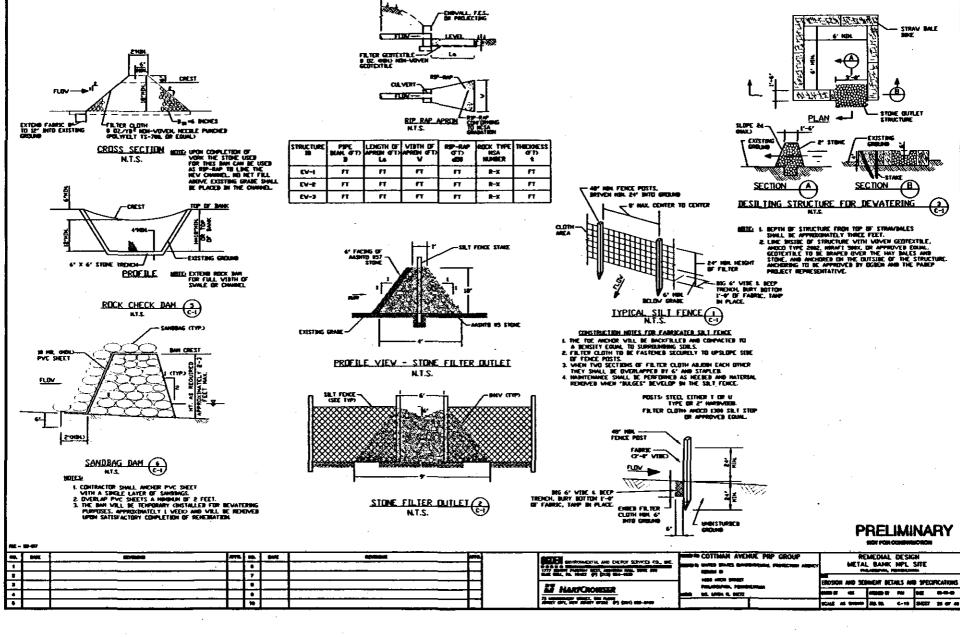












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ALL VORK SHALL BE BONE OF ACCURANCE VITA THE PENESYLVANIA TANDAMES FOR EROSEIN AND SERVENT CONTROL.

2. ALL SOB, EROSION AND SEMPENT CONTROL PRACTICES ARE TO BE INSTALLED, STABBLIZED AND FUNCTIONAL PRIOR TO ANY INJURY SOB. BISTURNACE, OR THE THE PROPER SECURICE, AND MAINTAINED UNITE. PROMADULE PROJECTION IS ESTABLISHED.

3 BOUFMAND V FIR I PLYING MATTER DISTRIBUTED OF STRICK GRADING. 3. PPERATELY PELLINNING METHIC MISTURMACC OR RELIAR GOURGE.
ALL CRITICAL AREAS SUBJECT TO TOPSKIN GE. STICEP SLOPES AND
EMARKHERTS VILL RECEIVE & TEMPERARY SEEDING IN COMBINATION
VITM STRAY RELEASE A SUITABLE GRAVALENT.

4. M.L. BISTURBED AREAS SHALL BE SEEDED IN ACCORDANCE WITH THE SPECIFICATIONS OF THE ERISSION AND SERBENTATION CONTROL PLAN.

S. THE COMPACTUR IS RESPONSIBLE FOR THE PROPER CONSTRUCTION, STABILIZATION AND MAINTENANCE OF ALL EMISSION AND SCHIPMINATION CONTROLS MERING ALL EMISSION OF CONSTRUCTION, CONTROLS MUST BE INSPICTED AFTER AND STORM C VICT

COMMANDE DE LEMMANTE MES STATEMENTS PRESENTES BY THE COMMANDAM FRANKES MUST BE PREMATELY PRESENTED THE PRESENT STATEMENT FROM THE PRESENT STATEMENT OF THE COMMANDAM STATEMENT OF THE PROPERTY OF THE PROPERTY

STACING OF CARTINGTING ACTIVITIES

EARTHNOVING ACTIVITIES WILL CONDINCE AS SEEN AS PRACTICABLE AFTER ISSUMDED OF RECURRED PERMITS FROM ALL ACTICES MAVING JURISDICTION AND MOTHER TO PRINCIPE FROM THE DAMER.

ENUMERATION AND SEMBLES AND EAST-MAKE EAST-MAKE AND EAST-MAKE EAST

ACTIVITIES VILL BE STAGED AS FILLINGS

1. 72 MOURS PRIOR TO MY EARTH DESTURBANCE NOTICE OF SUCH IN WRITING SWELL BE GIVEN TO THE PENOSYLVANIA REPARTMENT OF ENVIRONMENTAL PROTECTION CEMENOPOLICEIN.

2. HARK LINETS OF DESTURBANCE AND INSTALL TEMPORARY SAFETY FENCES AS SHOWN the THE E & S CONTROL PLAN BRANDESS CC-D.

3. PRIOR TO INITIATING EARTHNOVING ACTIVITIES, SR.T.-PENCES VILL BE BISTALLED BROWGE, OPE TO THE REPEDIATION AS DOWN ON THE EAS COUNTRIL PLAN BROWGE C-1) TO PREVIOUS SEDBERT FROM LEAVING THE SITE.

4. CONSTRUCTED ACCESS ROADS WILL BE INSTALLED IN THE LIBCATIONS SEGME UN THE EAS CONTROL HUAN BRANCHS. THE ACCESS WINDS WILL BE INSTALLED AND MAINTAINED AS BETAILED IN THE E B.S. CONTROL PLAN

S. PERSONNEL PROTECTION EQUIPMENT MIST BE USED AS REQUIRED BY THE REMEMBRATION ACTIVITY HEALTH AND SAFETY PLAN.

6. TEMPORARY REVATERBIG BASING VILL BE INSTALLED PRIOR TO THE CONSTRUCTION OF ANY STORMARKE CHAMBEL, LICATIONS OF THESE BASING ARE SHOWN (M) THE É & 2 CONTROL PLAN BANVING CI-D. THE CONTRACTOR VILL BOTALL BASING AS REQUIRED TO EXSURE THAT REVERTED ROUTE TO RELEASE DUTO UNISTRUMENT BANKES IN SECTION OF THE BASIN ALLOWED TO RECOMMENDING BANKES IN SECTION FILE ASSOCIATION OF THE BASIN.

7. RECK BMS AND SAMD BAG BMS VILL BE RISTALLED AS INDICATED IN THE E & S CONTROL PLAN BRANDIG C-D PRICE TO THE RECEIDATION OF ANY STREAM COMMINEL SECTION THE BMS WILL BEHAM IN PLACE UNTIL THE ENTIRE SECTION IS ABERUATELY STARRIZED.

R. TEMPORARY BEVERSIONS WILL BE DISTALLED UPSLOPE OF REMEDIATION AREAS TO BRIGHT SURFACE REAGET AWAY FROM AREAS OF DISTURBANCE. LICCATIONS AND INDEXESSES BY THESE INVERSIONS AND THYRIGHT SHOWN ON THE PLANG. THE CONFIDENCE OF WITH THE WILL STALL SHOW SPECIFICATIONS AN EQUIPMENT OF WITH THE PLANG. AND SPECIFICATIONS AS REQUIRED TO ENSURE THAT SHOPE THE BELLEY IS RELEASED ONTO UNDISTURBED SORE. IN SHEET FLOW AND HER STRUCTURE. THE CONTRACTOR MAY EMPLOY BELLEWISH OF THE STRUCTURE. THE CONTRACTOR MAY EMPLOY ALLEDWISH OF ENTERS OF BEVERING FLOW ACKNOWN INSTRUMENCE. MEAS) UPDI APPROVAL BY THE PENNSTLVANIA REPARTMENT OF ENVIRONMENTAL MOTEURON COMMANDACION.

9. SEVATERING SHALL SE PERFORMED TO THE SATISFACTION OF THE SEPARTHENT AND IN A HAMMER THAN FEBRATE STRAIGHTEN OF BALL BACKELL MATERIAL. HO DISTRALEMEN OF SHAUFEL SHALL SE PERMITTED TO SE CONSTRUCTED IN AN EXCAVARED AREA IN VASCAL WATER FLANS OR IN POSICE.

M. STUDOWATER CHANNEL CONSTRUCTION WILL BE INITIATED AT THE UPSTREAM LIMIT OF THE CHANNEL AND WILL PRINCIPLES IN A BUMMSTREAM BRACETION.

11. THE STUDBNATTER CHONNELS CAS SPECIFIED SHALL BE LINED WITH A STABILIZING GEORGICELE FARREC (TYPHR 34M MIN-VOIVEN GEORGETEXTILE DR APPROVED EDUNL) PRIOR THE THE PLACEMENT OF THE STONE MICKEL OR WILL BE GRASS LINES AS SIGNM BY THE ATTACHER TABLE.

12. THE CONTRACTOR SMALL PREPARE THE STORMAFTER CHMORELS, FOR THE PLACEHONT OF LIBRIDG IN ACCORDANCE VITH THE BRANZINGS, AND IN ACCORDANCE VITH THE BRANZINGS, AND IN SCIENCETATION CONTROL REGULATIONS. THE SMALL CONSIST OF SWATERINGS, ECCULATION, SHETPING, SUPPRING, SHAZINGS, ENCOYAL OF UNCUTTARLE INTERFALS OR CLEARING AND GRUDODIG RECESSARY TO ACCORDALISM THE VIDEO.

13. THE CONTRACTOR SHALL CARCILLLY PLACE SIDE, LIBRING US SPECIFIED WITHIN THE AREA PREPARED TO PROBLEME AN EVAN ESTREMITION FOR WATERAL, WITH A RESIDENCE CONTRACTOR SHE WITHOUT BANKGOIN THE GETTERING FASSEC. THE CONTRACTOR SHALL REASONED FOR LIBRING AT THE BEFORE HER CONTRACTOR SHALL REASONED FOR THE BEPARTMENT, AS RECESSARY, TO ENSURE EVEN BISTRIBUTION.

E4. PERFORM EARTHWORK IN ACCURANCE WITH SPECIFICATIONS .

IS. STAGENG/STORAGE AREAS FOR SOILS CONTAINING LEAD VILL BE CONSTRUCTED AND IMPARTABLED TO IMPROVED CONTAINING OF THE STRONG-BOOK ENVIRONMENT. THE LIGATION OF THESE AREAS OF APPROVED FOUND. VILL BE INSTALLED AND MAINTAINED AS BETAILED ON THE 6 & CONTROL FLAN BRAVING C-13. THE LIGATION OF THESE AREAS. AREA PROVIDED ON THE C & S CONTROL FLAN BRAVING C-13.

IG. STOCKPRES OF BACKFRE VIRE HE HORSTEED AND VIRE DRLY BE LIZENTED DISTIF AT THE IMPECTION OF THE USERA. ALL STOCKPRES VILE BE SUMMERIMED VITH SET FECKE, UNITED TO 25 FEET ON RETINET AND HAVE A MACHINE S SHOUGHEST VIEW OF THE STOCKPRES VIEW

17. BACKFRI. ANY INSTURBED AREA WITH CLEAN BACKFRI. AND STABILIZE. STABILIZATION WILL INCLUDE: REVEGETATION PER SPECIFICATIONS

IB. LPDM COPPLETION OF RENEDRAL ACTIVITIES, ALL DISTURBED AVEAS VALL
BE ENEPCECED TO ENSURE STABILIZATION. ATTER THE SITE IS.
PERMANENTLY STABILIZED AND LPDM FROM. ATTER THE SITE IS.
SILF FERENCIANYMOLES, PLASTIC SAFETY FERENCY, STABILIZED TUPPURMY
CONSTRUCTION ENTRANCES, AND ANY TERPURMY ACCESS SENAN VALL BE REQUED.

HADITFIANCE OF CONTROL FACILITIES

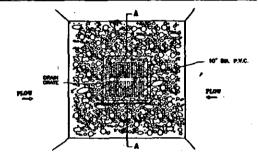
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OF ALL CRUSSION AND SCHRONTAIREN CONTROLS AFFER CACH STURM EVENT
AND ON A VEOLILY BASIS ALL PREVENTATIVE AND FROMMAN
MARKEMANCE VORK, SACLURING CLEAN OUT, REPARR, REPLACEMENT
RE-RALCOME AND RE-RESTORMED MISS THE PERFORMED PROPERTY.

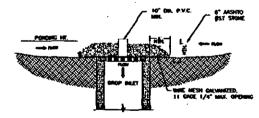
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TYPEAL STORMANTIN CHARGE, SECTION

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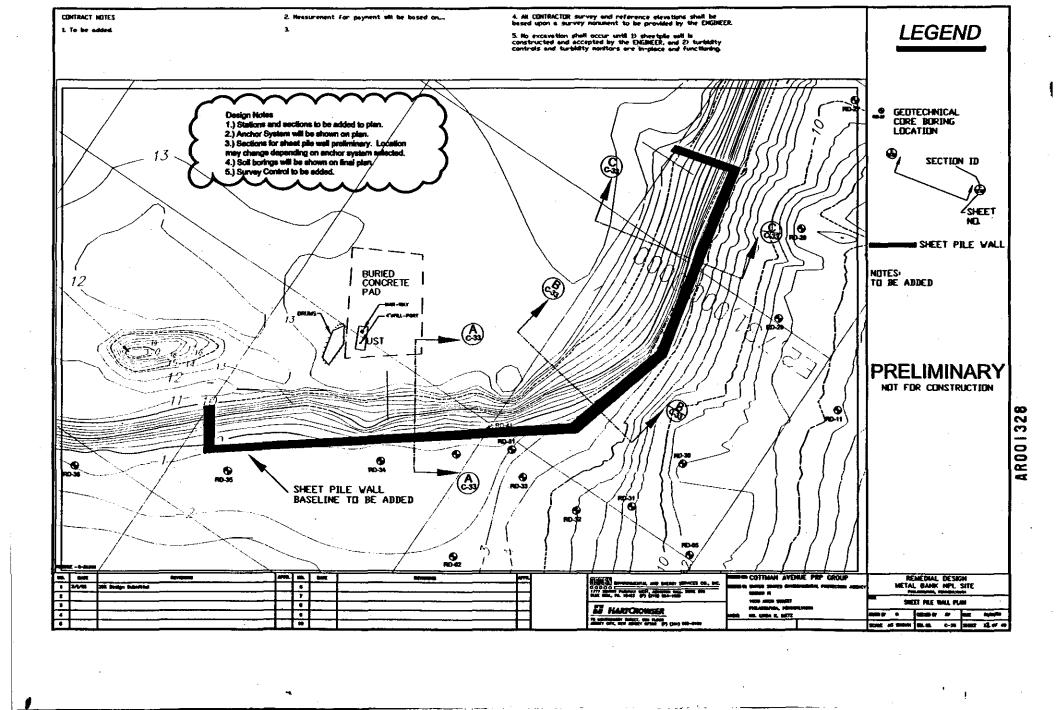
PLAN VIEW - DROP INLET SEDIMENT PROTECTION N.T.S.

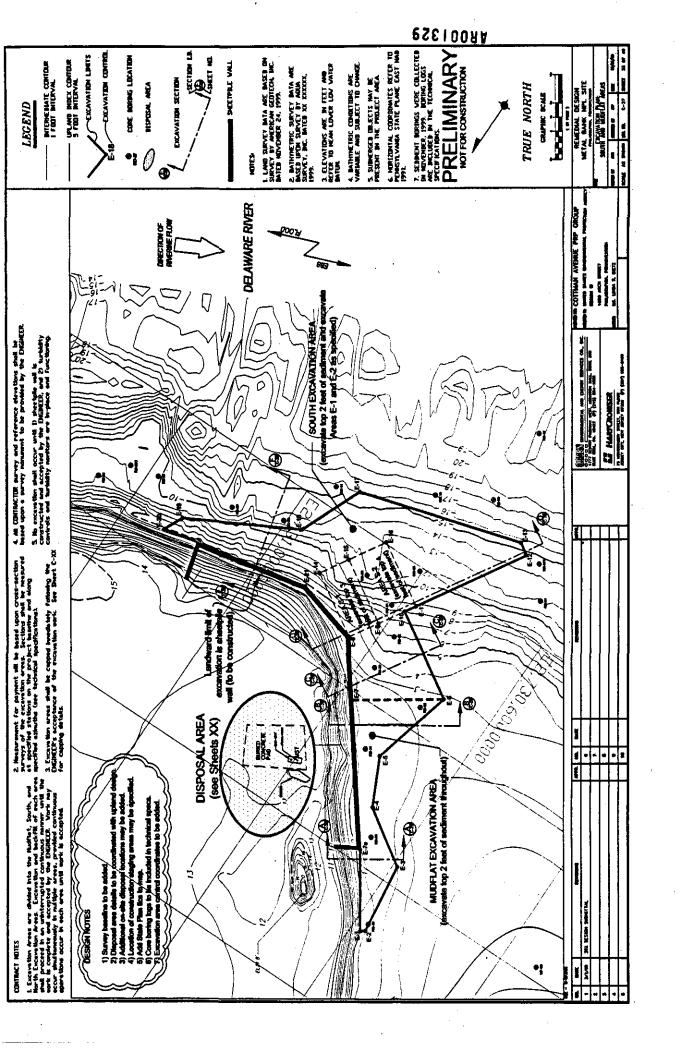


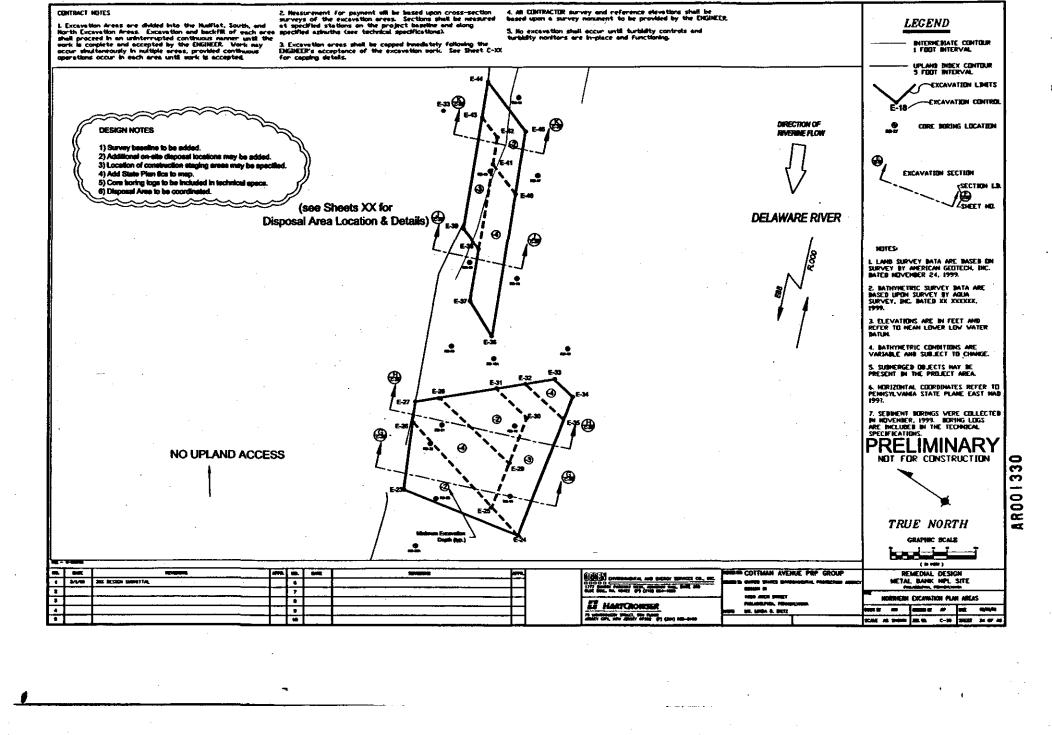
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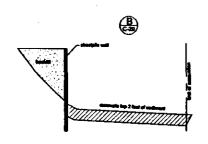
SECTION VIEW - DROP INLET SEDIMENT PROTECTION N.T.S.

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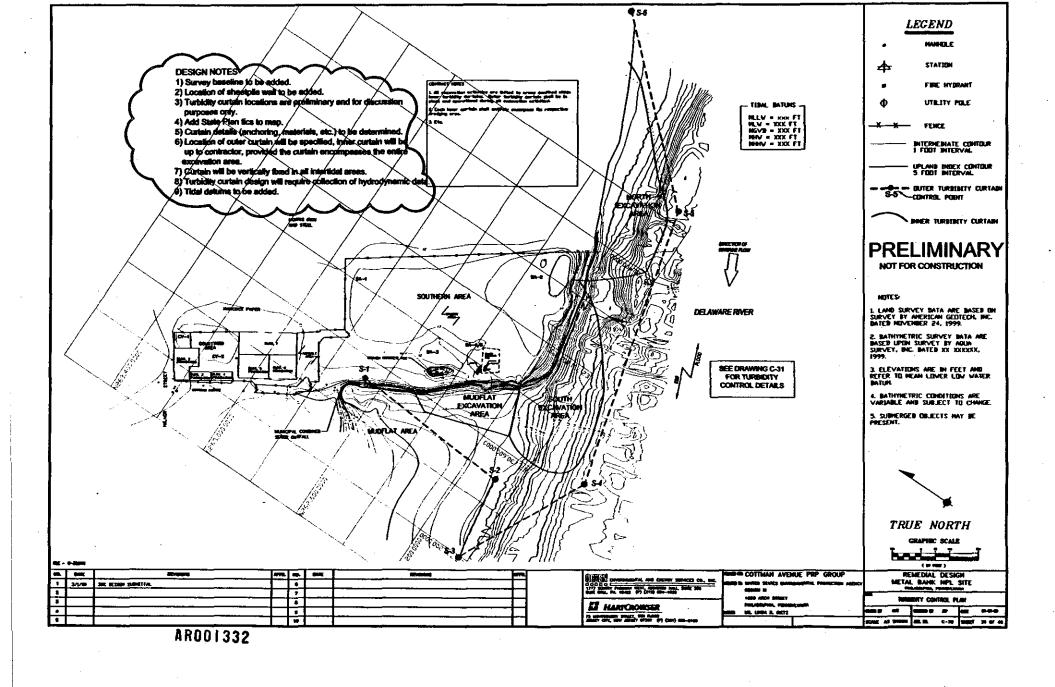


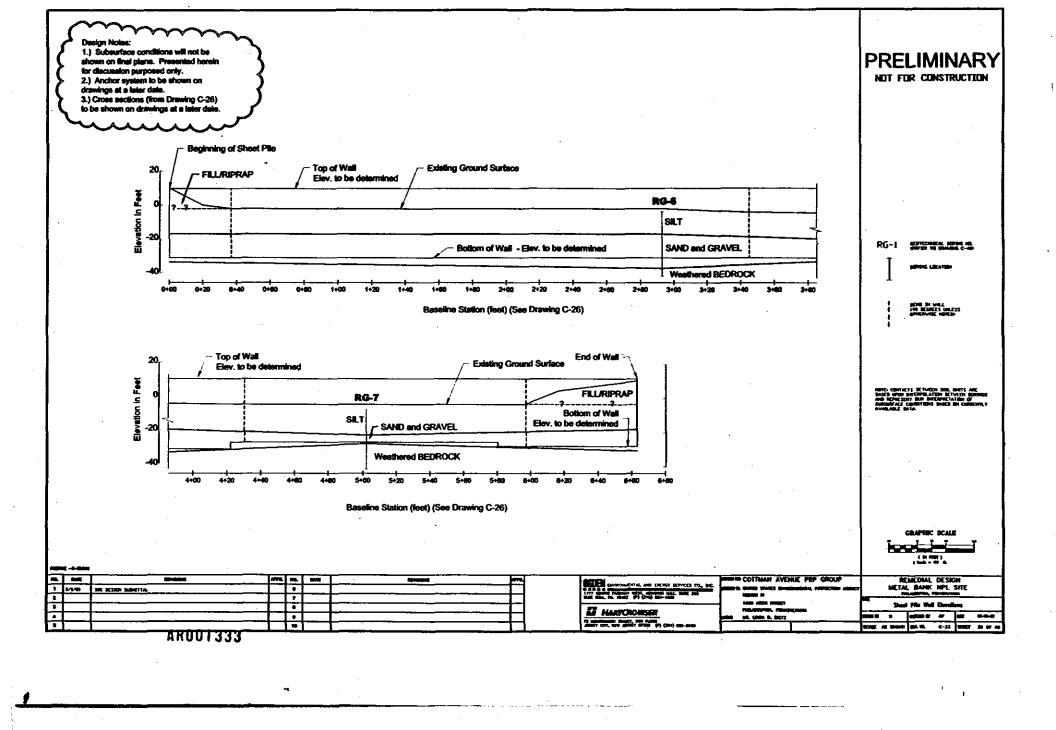


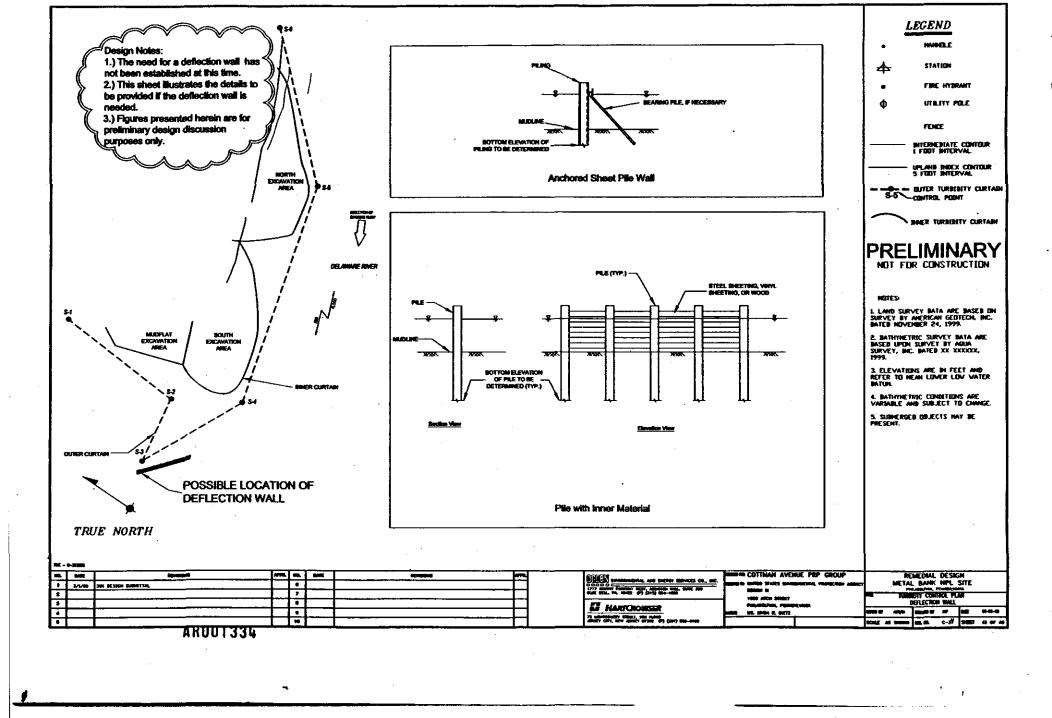
REMAINING SECTIONS TO BE ADDED

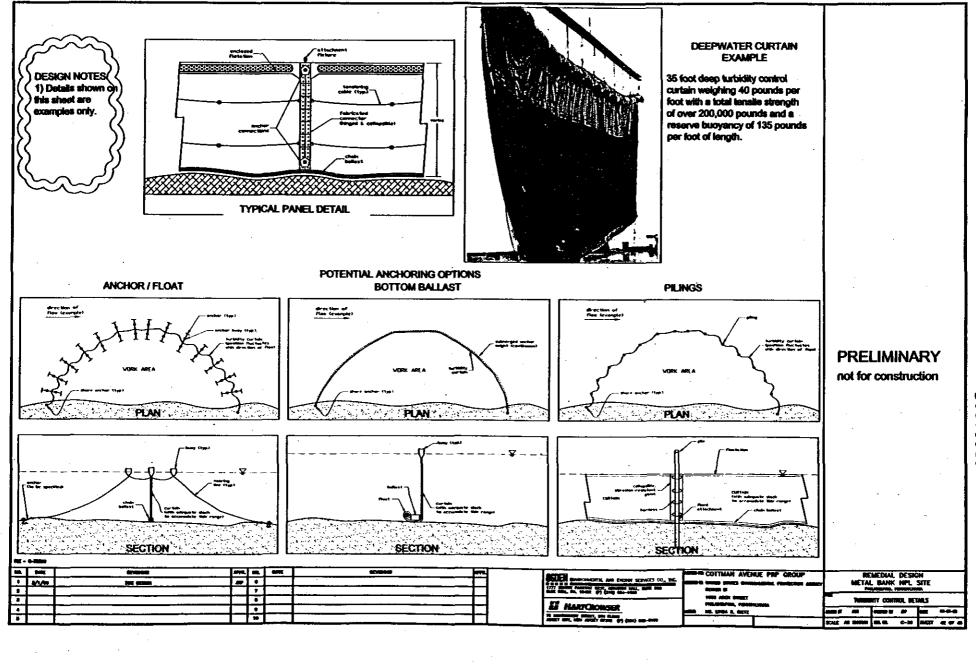
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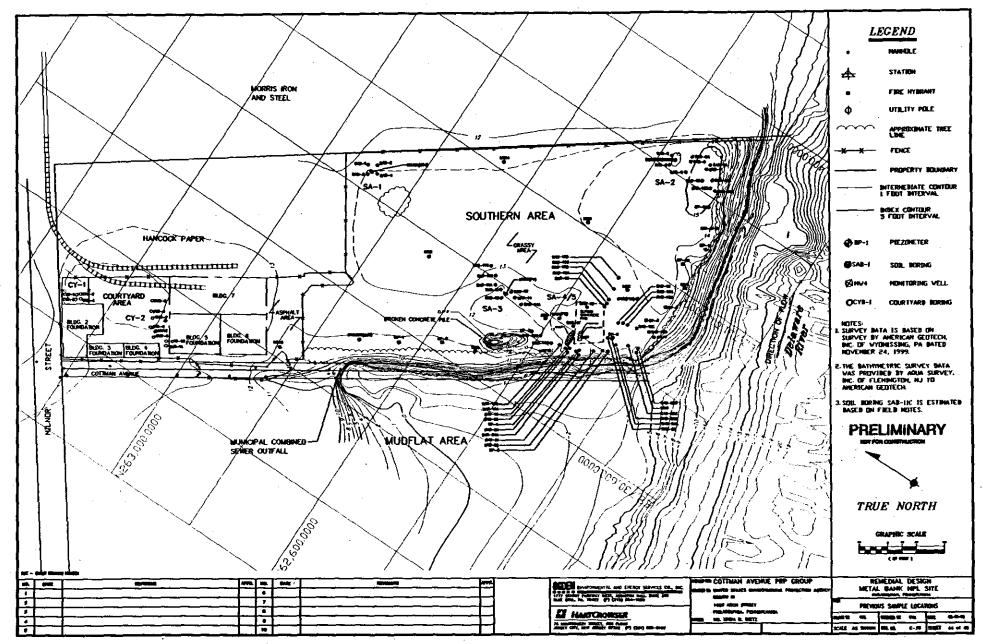
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SCHL HORING COURDINATES							
SAB #	NORTHING	EASTING	CROUND EL. CETX				
1	262907.1732	2730850.1824	12.541				
S	262890.1593	2730860.5386	12.769				
3	262880.8376	2730844.9622	13.020				
4	262896.9383	2730832.6150	13.136				
<u> </u>	262378.5246	2731227.8826	14.758				
6	262337.4945	2731.239.2914	14.970				
64	262340.2648	2731248.9840	14.921				
7	262300.3193	2731244.3976	.15.293				
7A	262298.3969	2731256.4049	15.233				
<u>B</u>	262370.5868	2731208.8779	14.866				
9	262333.7229	2731214.6173	14.962				
10	262294.4966	2731218.3939	15.007				
IOA	262276.6823	2731231.1644	15.253				
IOB	262271.1003	2731215.2626	15.339				
10C	262259.1961	2731215.2545	15.407				
11	262524.7177	2730787.6373	11.723				
11A	262538.7857	2730789.8774	12.376				
IIB	262549.7251	2730806.0779	12.498				
IIC	262543.9910	2730809,2654	12.624				
15	262502.7113	2730795.3635	12.044				
13	262512.9178	2730773.7043	11.924				
14	262489.1521	2730789,9359	12.175				
14A	262469.9126	2730785.4917	12.158				
15	262349.9506	2730858.4949	13.200				
16	262319.5431	2730879.7074	13.136				
16A	262319.5713	2730888.3495	13.295				
168	262320.8808	2730897.6849	13.168				
16C	262324.8600	2730922.6580	13.315				
16D	262329.0175	2730947.4571	13.593				
17	262351.7046	2730808.5852	13.383				
18	262276.2889	2730867.5910	13.453				
18A	262267.8525	2730872.4183	13.475				
188	262257.5868	2730874.7354	13.544				
180	262237.5880	2730879.9884	13.642				
180	262210.5269	2730888.1460	13.766				
19	262332,9899	2730764.7770	13.079				
19A	262340.3314	2730759.5395	13.105				
19B	262353.9110	2730759.8332	12.937				
19C	262370.7391	2730752.5733	12.883				
190	262399.0921	2730753.4090	12.581				
20	262277.2030	2730828.3789	13.635				
20A	262268.8820	2730831.6699	14.080				
20B	262255.2118	2730825.3957	13.918				
50C	262232.0341	2730838.3098	13.875				
	262211.1300	2730844.8615	14.065				
20b 21	262287.3997	2730787.9954	13.299				
SS	262271.4925	2730798.9128	13.316 .				
23	262331.2968	2730755.2968	13.122				
24	262313.5808	2730772.8354	13.062				
24A	262308.5673	2730764.1474	13.042				
	LUL300.30/3	E,30,04,14,4	LUND'NE				

MONETORING VELL COORDINATES

		· · 	ELEVATION OF		
HV 8	NORTHING	EASTING	GROUND	TUBING	
1	262892.2326	2730841.9584	13.30	MA	
5	262690.8973	2730759.8255	13.06	15.25	
3	262448.5812	2731009.6553	14.26	16.06	
4	262198.3282	2731008.8231	13.65	15.731	
44	262212.3229	2731151.7681	13.83	14.16	
6	262209.6547	2730836.3988	14.25	15.911	
7	262365.5696	2730736.5951	1314	14.11	
8	262497.4160	2730648.0931	11.39	12.75	
9	262410.5620	2730789.5394	12.92	14.57	
10	262509.3832	2730786.0249	12.33	14.22	
11	262715.5330	2730530.9664	11.49	13.77	
_ 12	263088.6999	2730302.0454	13.90	NA	
13	262849.5061	2730422.3578	11.95	M	
14	262668.7766	2731016.3307	13.94	NA	
15	262365.9397	2731223.3128	15.21	16.83	
~	262385.9531	2730806.5561	13.44	15.92	
	262271.2441	2730932.7455	13.98	16.10	
C	262299.8368	2730936.3271	13.86	15.46	

PIEZOMETER COURDIANTES

			ELEVATION OF	
BP-8	NORTHING	EASTING	GROUND	TUBING
1	262642.5277	2730572.7400	11.60	14.29
5	262565.3518	2730624.7947	11.14	13.02
3	262419.7762	2730750.0969	11.85	13.86
4	262317.7629	2730766.7899	13.22	15.44
_ 5	262269.2732	2730834.9934	14.25	16.23
6	262261.3913	2730803.8923	13.93	16.00
7	262195.0630	2730895.2391	13.65	16.00
. 9	262228.0386	2730905.6817	13.95	16.38
9	262209.1540	2730952.1710	14.16	16.29
10	262230.1360	2731048.7276	13.08	15.47
. 11	262207.1156	2731101.4065	13.24	15.31
12	262252.0502	2731179.9260	14.94	16.64

COURTYARD SAMPLE COORDINATES

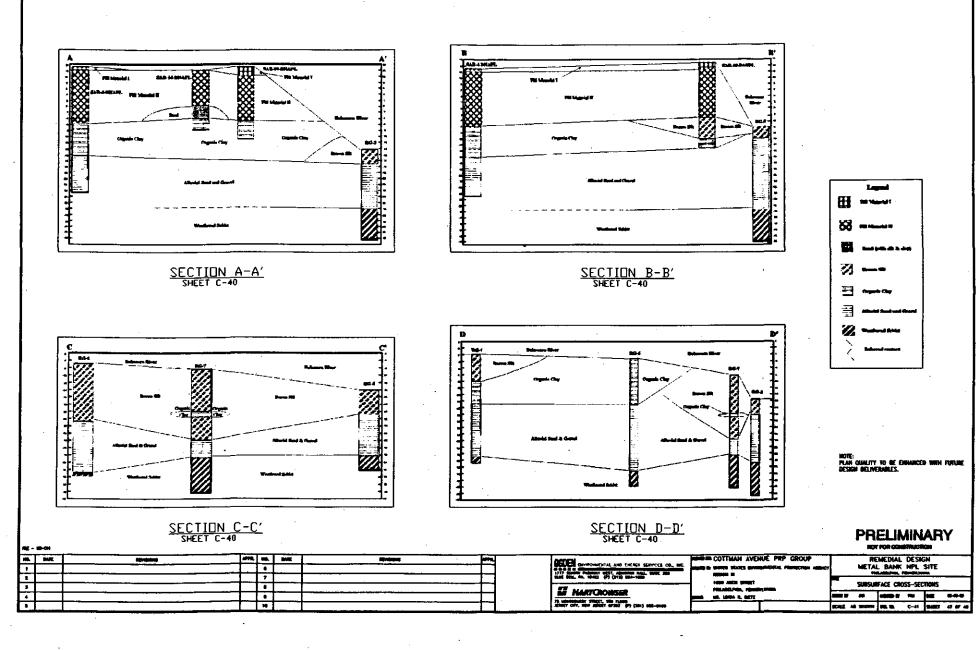
NURTHING	EASTING
263273.5063	2730272.6434
263267.2692	2730278.0128
263270.0607	2730263.3053
263261.2889	2730270.0577
263131.0794	273035.0354
	2730332.8413
263109.8431	2730322.7522
263102.4643	2730304.2694
263085.1675	2730290.2374
263057.9652	2730297.8392
263052.9676	2730289.2684
	263273.5063 26326726592 263270.0607 263261.2889 263131.0794 263120.9331 263109.8431 263102.4643 2630551.675 263057.9652

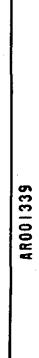
- NOTES: THE SURVEY DATA IS BASED ON THE STAMPED SURVEY DRAVING PRODUCED BY AMERICAN GEOTECH, INC. OF VYOMISSING, PA, DATED NEWEMBER 24, 1999 AND SIGNED DECEMBER 9, 1999.
- 2. VELL BESIGNATIONS ARE BASED ON INFORMATION FROM PREVIOUS REPORTS AND FIGURES OR FROM IDENTIFICATION PLATES LOCATED ON INSIDE OF VELL CAPS. MONITORING VELLS A, B, AND C HAB DISCREPANCIES DETVEEN THE REPORTS AND VELL CAPS.
- 3. THE LOCATION OF SOIL BORING SAB-IIC ON THE FIGURE IS ESTIMATED BASED ON FIELD NOTES. THE SURVEY COORDINATES ARE BELIEVED TO CORRELATE TO AN ATTEMPTED BORING NEAR SAB-IIR.

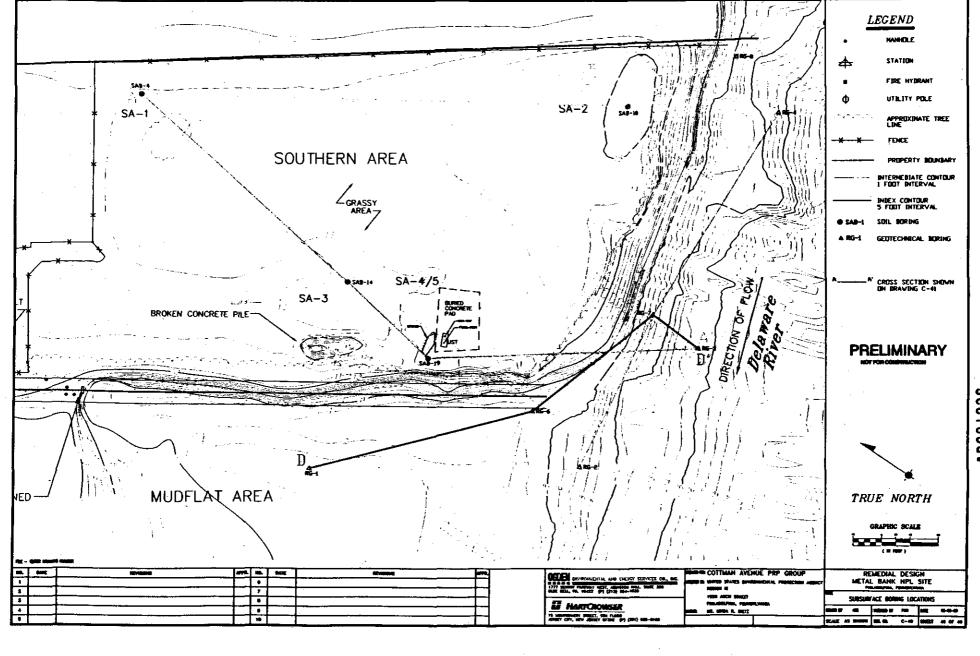
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-	1	APPO. 144	- ME		METER DESIGN AVENUE PRP GROUP REMEDIAL DESIGN
		•			DEPONDENT AND DEPON SERVICE CO. DC. 177 SURFER PARTY COLD, ARREST SERVICE CO. DC. 177 SURFER PARTY COLD, ARREST SERVICE CO. DC. 178 SURFER PARTY COLD, ARREST SERVICE CO. DC. 178 SURFER PARTY COLD, ARREST SERVICE CO. DC. 179 SURFER PARTY COLD, ARREST SERVICE CO. DC. 170 SURFER PARTY CO. DC. 170 SURFER PARTY CO. DC. 170 SURFER PARTY CO. DC. 170
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3					HARTCROMSER PROPERTY PREVIOUS SAFEE LOCATION CONTINUES
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APPENDIX 3

Erosion and Sediment Control Information

VENDOR INFORMATION

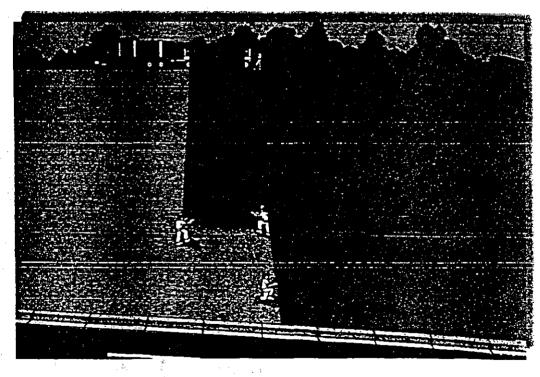
Erosion and Sedimentation Control Materials





Degradable Erosion Control Blankets

- ▲ Steep Flores
- ▲ Low Fow Channels
- ▲ Flexible Bioengineering Textile
- ▲ Ancher for Straw/Hav Mulches
- ▲ Sod Rainforcement Underlay





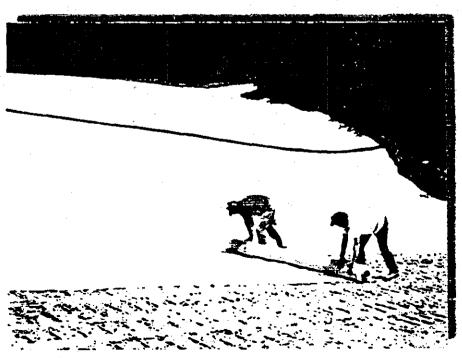
LANDLOK* Degradable Erosion Control Blankets

_andlok[®] degradable erosion control blankets are flexible erosion control products designed to hold seeds and soil in place until vegetation is established. The natural looking, high strength polypropylene mesh protects the soil surface from water and wind erosion while offering partial shading and heat storage to accelerate vegetative development.

Landlok erosion control blankets are manufactured using a unique process in which perpendicular rows of multifilament and tape yarns are woven into a dimensionally stable matrix. Utilizing the concept of differential photodegradation, the tape yarns break down first, followed by the multifilament yarns. As photodegradation progresses, the fibers are broken down into shorter and shorter segments which become part of the soil.

Available in extra wide 3.81-meter (12.5-foot) rolls. Landlok temporary erosion control blankets are less expensive and easier to handle, store and install than traditional straw, excelsior, coconut and jute blankets. Unlike these materials, this flexible mesh does not absorb water and maintains high strength and dimensional stability when challenged under saturated conditions. If protected from UV degradation, rolls of Landlok erosion control blankets may be stored outside with no fear of moisture absorption and subsequent strength loss due to rotting.

Differing from the fused plastic nettings used to reinforce "organic" blankets, the woven mesh opens to allow uninhibited growth of woody plant species. As degradation progresses, larger and larger plants emerge unconstricted, making Landlok erosion control blankets ideal for environmentally sensitive bioengineering applications. This material is a cost-effective alternative to bioengineering textiles constructed frexotic fibers.



Landlok® erosion control blankets for steep slope protection



Slope facing for bioengineering



Emergence of vegetation through non-fused matrix

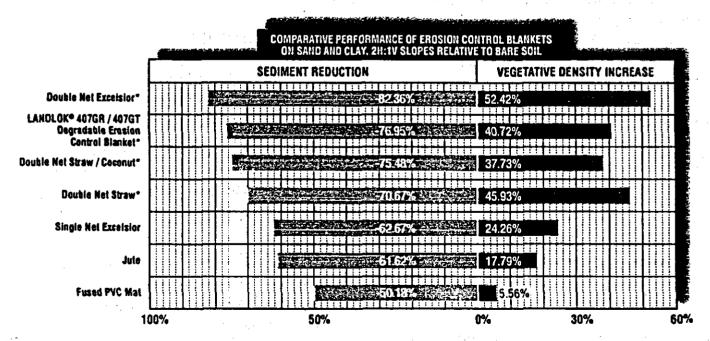
Proven Performance

A variety of manufacturing processes are used to produce "roll-type" erosion control materials, making it difficult to directly relate physical properties to performance. The true test of performance is independent evaluation under identical field conditions. In 1991, the Texas Transportation Institute (TTI) initiated a comprehensive study of erosion control products.

A wide array of products were evaluated on carefully constructed sand and clay, 2H:1V and 3H:1V slopes. Each material's test plot was fertilized and seeded per standard Texas DOT specifications and subjected to simulated rainfall corresponding to one, two and five year events, all within six weeks after installation. In addition, the study area endured an extremely wet year receiving nearly 172 centimeters (68 inches) of natural precipitaon, well above the annual norm of 99 centimeters 39 inches).

Each plot was closely monitored for vegetation density and soil loss (sediment reduction) after each simulated rainfall event and at the completion of the one year study. Landlok® 407GR/407GT erosion control blanket was tested among the upper echelon of materials on the more demanding 2H:1V slopes. Ranked performance of each product's ability to retain soil and promote vegetative growth is presented in the figure below. Landlok 407GR/407GT erosion control blanket was among the top performers in this important study, outperforming higher cost products and placing second overall in combined ability to retain soil and establish vegetation.

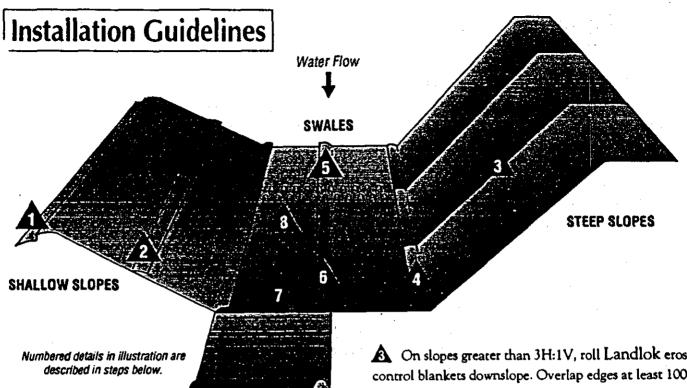
Landlok erosion control blankets have been approved by the Federal Highway Administration [FP-96, 713.07(4)], numerous state DOTs and other agencies.



From: Field Performance Testing of Roll-Type Erosion Control Blankets through the Erosion Control Field Laboratory.

Proceedings of the XXIV Annual Conference of the International Erosion Control Association, 1993.

Sediment reduction values and vegetative density increases not significantly different.



SITE PREPARATION

Prepare seedbed, then apply seed, fertilizer and/or soil amendments per specifications prior to installation. Seed may be placed after installation when using Landlok® erosion control blanket as a reinforcement scrim for hydraulic mulches. When using this material to anchor straw or hay mulches, apply mulch at no more than 112 kg/ha (1 ton/acre). Then install Landlok erosion control blanket per the following guidelines:

SLOPES

A Construct a 150 x 300 mm (6" x 12") anchor trench 600-900 mm (2'-3') beyond crest of slope. Staple Landlok erosion control blanket in trench on 300 mm (1') spacings, backfill and compact soil.

A On slopes flatter than 3H:1V, Landlok erosion control blanket can be installed across or down the slope face. Overlap edges with the upslope material on top. Staple along centerline of overlap using general stapling pattern.

A On slopes greater than 3H:1V, roll Landlok erosion control blankets downslope. Overlap edges at least 100 mm (4"). Staple along centerline of overlap using general stapling pattern.

A Shingle-lap Landlok erosion control blanket roll ends on slopes a minimum of 100 mm (4") and in the direction of water flow. Staple overlap on 300 mm (1') spacings.

SWALES OR DITCHES

A Construct a 300 mm (12") deep anchor trench at the upgrade end of the installation to inhibit undercutting by surface runoff (see detail A in the above illustration).

A Straw or hay may be placed beneath Landlok erosion control blanket for additional protection and/or moisture retention. Overlap the edges at least 100 mm (4") and staple down center of overlap using general stapling pattern.

A Shingle-lap end of rolls at least 300 mm (1') with upstream material on top and in the direction of water flow. Anchor overlap with two rows of staples 300 mm (1') apart on 300 mm (1') spacings.

At 7.6-9.1 m (25'-30') intervals along the channel bottom, apply a row of staples 150 mm (6") apart. Then place a second row of staples 150 mm (6") below the first row in a staggered pattern.

AR001346

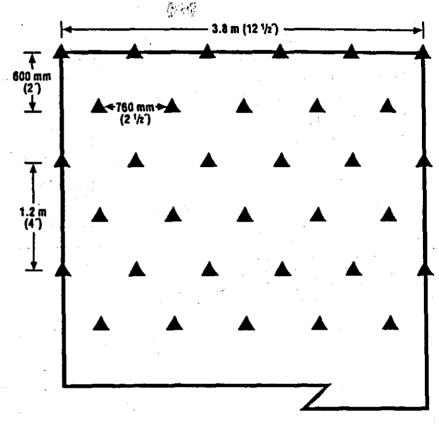
Staple Requirements

ANCHORS

To insure optimum performance Landlok® erosion control blanket must be anchored as illustrated here. Use 150 x 25 x 150 mm (6" x 1" x 6"), 3 mm (11 gauge) U-shaped wire staples. Loose, rocky or highly compacted soils may require longer and/or heavier gauge staples.

AS SOD REINFORCEMENT UNDERLAY

When using Landlok erosion control blankets as an underlay for sod reinforcement, secure material in a 300 mm (12") deep anchor trench 600-900 mm (2'-3') above crest of slope or channel. Anchor the material into the trench on 300 mm (1') spacings, backfill and compact soil. Roll out Landlok erosion control blanket using standard installation and overlap procedures anchoring all overlaps on 1.2 m (4') centers. Install additional staples as required to temporarily anchor the product in place. Working upward from bottom of slope or channel, install sod using standard methods. Place staples through sod as required for stabilization and to prevent slippage, typically on 1.2-1.8 m (4'-6') centers.



2 STAPLES/m² (2 1/2 / yd²) MINIMUM

AS A BIOENGINEERING TEXTILE

Degradable Landlok erosion control blankets are an ideal facing for bioengineering applications. The fine aperture size provides surface soil stabilization which protects seeds and young woody plants in the critical early phases of growth. As the plant materials develop, roots and shoots will pass unconstricted through the degrading material. Landlok erosion control blankets are easily cut for plantings through the matrix. The wide rolls are also ideal for wrapped face designs when construction is done in lifts.

Consult with a manufacturer's technical representative or local distributor for installation assistance, particularly if unique conditions apply.

Industry Leaders

ENGINEERING SPECIFICATIONS

The flexible, open weave, natural beige erosion control blanket shall be manufactured from perpendicular rows of photodegradable polypropylene multifilament and tape yarns woven into a dimensionally stable matrix. The non-fused, freely opening matrix shall possess strength and elongation properties to limit stretching and shall confer to the adjacent property values when fully saturated:

		LANDLOK® 407GT		
PROPERTY	TEST METHOD	ENGLISH A	METRICA	
Tensile Strength▲	ASTM D-4632	35 x 20 lbs	155 x 85 N	
Elongation at Break (max) A	ASTM D-4632	45 %	45 %	
Mullen Burst Strength	ASTM D-3786	75 psi	515 kPa	
Mass Per Unit Area	ASTM D-5261	1.75 oz/yd²	55 gr/m²	
Aperture Size	Measured	0.10 x 0.12 in	2.5 x 3.0 mm	
Moisture Absorption	ASTM D-570	0.01 %	0.01 %	
Smolder Resistance	FTMS-CC-5-191B	Yes	Yes	

▲ All values are Minimum Average Roll Values (MARV) unless otherwise indicated. ▲ Values for both machine and cross machine directions under dry or saturated conditions.

		1
有种种的 包含在120	ROLL CHARACTERIST	の高語という。
DIMENSION	ENGLISH	METRIC
Standard Roll Sizes	12.5" x 432'/4' x 432'	3.81 x 131.7 m/1.21 x 131.7 m
Roll Area	600 yd²/192 yd²	501.6 m²/160.5 m²
Roll Weight	90 lbs/30 lbs	40.9 kg/13.6 kg

SMART SOLUTIONS³

Analyzing and solving civil and environmental problems is our focus. We want to work with you on your next project.

FOR ADDITIONAL INFORMATION, PLEASE CALL:

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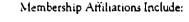
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- GEOFIBERS™ 3-dimensional soil reinforcement fibers
- FIBERMESH[®] fibers for concrete reinforcement

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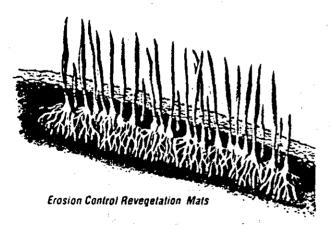
EROSION

LANDLOK EROSION MATS®

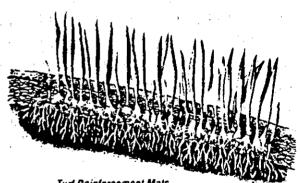
- Roadside Ditches
- Stormwater Channels
- Detention & Retention
- **Banks & Shorelines**

- ◆ Dams, Dikes & Levees
- Steep Slopes
- Geosynthetic Reinforced Earth Structures
- **Landfill Slopes & Diversion Ditches**

ANDLOK EROSION MATS are effective from the moment they are installed, providing superior temporary erosion protection, rapid vegetative establishment, and outstanding long term erosion resistance to tractive forces (sheer stresses) associated with high flow velocities of steep slopes and channels.



LANDLOK ECRM 450 is an erosion control and revegetation matrix comprised of a dense. three-dimensional web of green polyolefin fibers oriented and mechanically bonded between two nets. This matrix has been designed to provide maximum erosion protection without sacrificing optimal ground coverage (= 75%) while allowing for growth of vegetation through the mat.



Turf Reinforcement Mats

LANDLOK TRM 1060 is a Turf Reinforcement Matrix consisting of a lofty threedimensional web of black polyolefin fibers positioned between two high strength. biaxially oriented nets mechanically bound together by polyolefin stitching to form a dimensionally stable matrix. LANDLOK TRM 1060 has sufficient thickness (>1/2") and void space (>90%), balanced with optimal ground cover (= 60%) to allow soil filling and/or retention as well as emergence of plants from beneath or within the matrix. Soil. "the quintessential mulch", acts as a womb to induce seed germination, nurture seedling development and allow the root system to become entangled with the geosynthetic matrix.



EROSION CONTROL

POLYJUTE®

- ◆ Inexpensive
- ◆ Extra Wide Rolls
- ◆ Easy Handling, Storage and Installation
- ◆ Maintains Strength When Wet
- ◆ Accelerates Vegetative Development
- Photodegradable/Nonpermanent

- "Environmentally Friendly".
- ◆ Steep Slopes
- ◆ Low Flow Channels
- Bioengineering Geotextile
- ◆ Anchor for Straw/Hay Mulches
- ◆ Sod Reinforcement Underlay

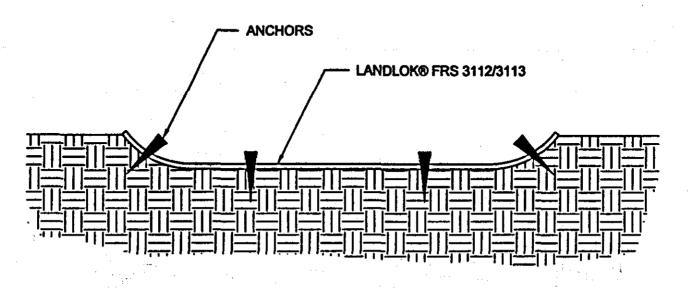
POLYJUTE® open weave geotextile is a flexible erosion control product designed to hold seeds and soil in place until vegetation is established. The natural looking, high strength polypropylene mesh protects the soil surface from water and wind erosion while offering partial shading and heat storage to accelerate vegetative development.

As the plant materials develop, roots and shoots will pass unconstricted through the degrading material. POLYJUTE® erosion mesh is easily cut for plantings through the matrix.

	MARV• ,		
PROPERTY	TEST METHOD	ENGLISH	METRIC
▲ Tensile Strength®	ASTM D-4632	35 x 20 lbs	155 x 85 N
▲ Elongation at Break (max) ●	ASTM D-4632	45 %	45 %
▲ Mullen Burst Strength	ASTM D-3786	75 psi	515 k Pa
▲ Mass Per Unit Area	ASTM D-5261	1.75 oz/ yd ²	55 gr/ m ²
▲ Aperture Size	Measured	0.10 x 0.12 inch	2.5 x 3.0 mm
▲ Moisture Absorption	ASTM D-570	0.01 %	0.01 %
▲ Smolder Resistance	FTMS-CC-5-191B	Yes	Yes
· · · · · · · · · · · · · · · · · · ·			•

All values are Minimum Average Rell Values (MARV) Unless Otherwise Indicated
 Values for Both Machine and Cross Machine Directions Under Dry or Saturated Conditions

	ROLL CHARACTERISTICS		
DIMENSION	ENGLISH	METRIC	
▲ Standard Roll Sizes	12.5' x 432' / 4' x 432'	3.81 x 131.7 m / 1.21 x 131.7 m	
▲ Roll Areas	600 yd 2/192 yd 2	501.6 m ² /160.5 m ²	
▲ Roll Weights	90 lbs / 30 lbs	40.9 kg / 13.6 kg	



- 1. 15.2 x 15.2 cm (6 x 6 in) DEEP CHECK SLOTS ALONG SWALE LENGTH @ 7.6 9.1 m (25 30 ft) **INTERVALS**
- 2. ANCHORS ON 0.3 m (1 ft) CENTERS PROTRUDING 7.6 10.2 cm (3 4 in) ABOVE SURFACE (OPTIONAL)
- 3. APPLY LANDLOK® FRS 3112/3113 @ 0.08 0.14 kg/m² (0.15 0.25 lb/yd²) (WITH TACK COAT APPLICATION)



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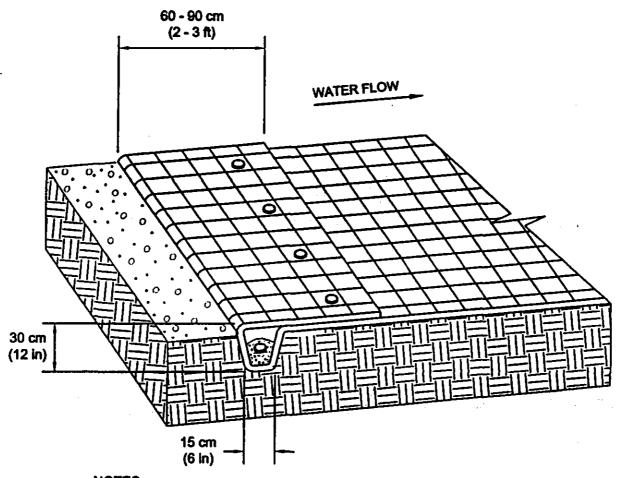
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of its suitability, applicability and accuracy.

Please note that the information presented herein is general information only. It is for conceptual use only and not intended to be used for construction. While every effort has been made to ensure its accuracy, this information should not be used for a specific application without independent professional examination and verification

Δ			FRS Swale L	ayout		
∇		Date:	Drawn Scale:			11/
Rev	Date	6/12/	/98 ^{By:} DLH	NTS	·	/1

FILENAME: FRS Swale Layout



1. PLACE 3 ANCHOR / m² (2 1/2 ANCHORS / Yd²) FOR CHANNELS



Phone:

SYNTHETIC INDUSTRIES

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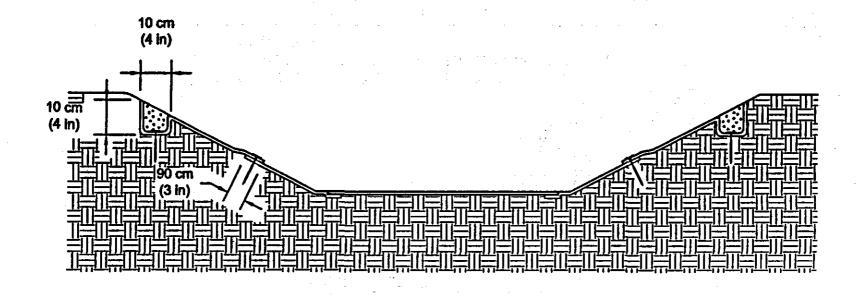
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\triangle		Terminal Channel Anchor Trench	
Δ		Orawn Scale:	11/
Rev	Date	10/98 By: DLH NTS	

FILENAME: Terminul Anchor Trench



- 1. PLACE 3 ANCHOR / m² (2 1/2 ANCHORS / Yd²) FOR CHANNELS
- 2. EXTEND LANDLOK® or PYRAMAT® TURF REINFORCEMENT MAT (OR EQUAL) TO ACCOMODATE MAXIMUM DESIGNED FLOW DEPTH



Please note that the information presented herein is general information only. It is for conceptual use only and not intended to be used for construction. While every effort has been made to ensure its accuracy, this information should not be used for a specific application without independent professional examination and verification of its suitability, applicability and accuracy.

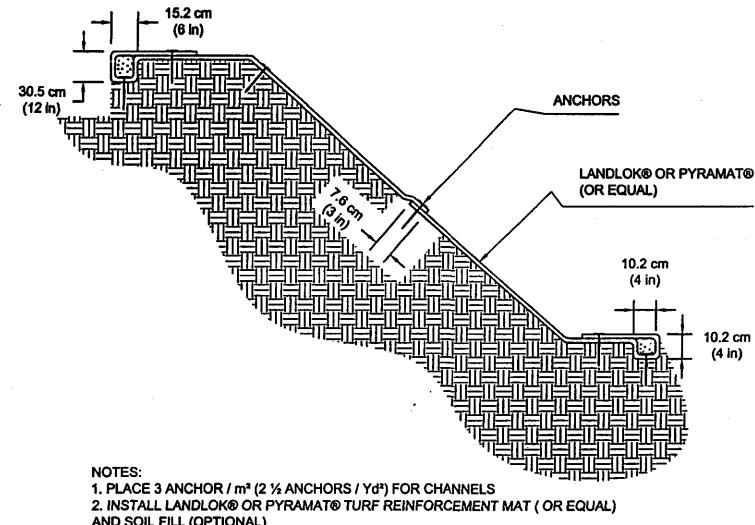
Typical Channel Cross-Section

Dote: Prown Scole:

Rev Dote 6/11/98 By: DLH NTS

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Phone: 1-800-FIX-SOIL Fax: 1-423-485-9068

FILENAME: Typical Channel Cross Section



AND SOIL FILL (OPTIONAL)



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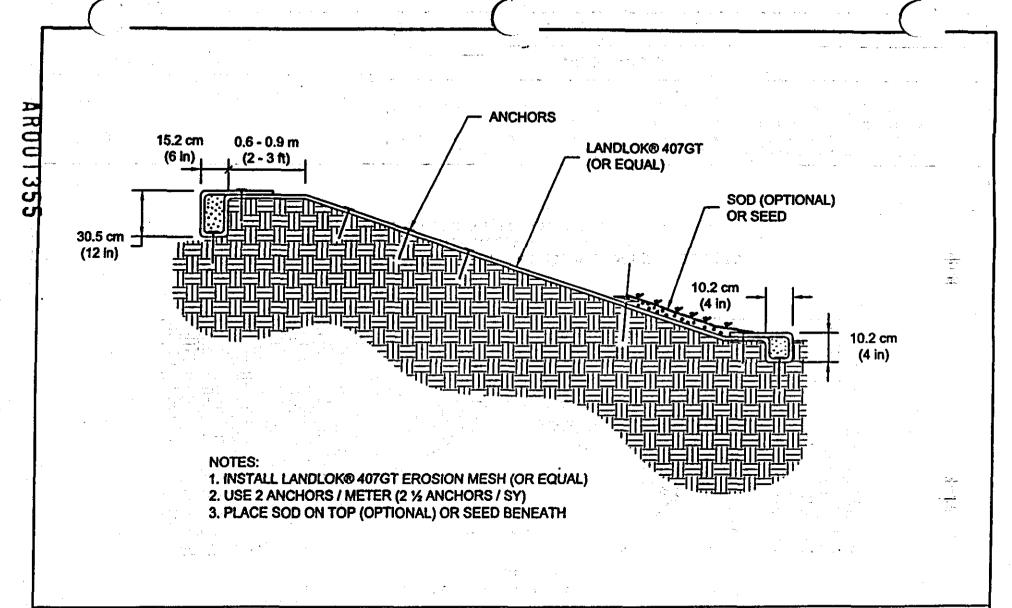
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	Typical Slope Cross-Section		Typical Slope Cross-Section		
		9-1-	Drawn Scale:		11/
Rev	Date	12	/98 ^{By:} DLH	NTS	

FILENAME: Typicor Slope Cross Section

Phone:



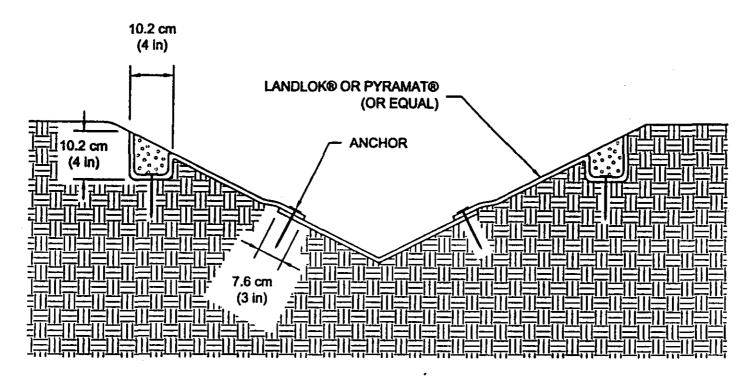


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Challanooga, TN 37416 1-423-485-9068 of its suitability, applicability and accuracy.

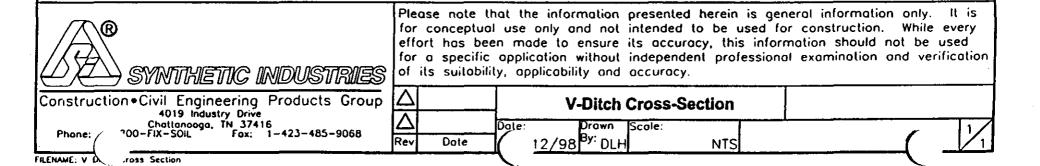
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	<u> </u>	Typical	Slope t	for LANDL	OK 40	7GT	
				Scole:	T.		 1/
Rev	/ Date	6/12/98	By: DLH	·	NTS		 /1



1. EXTEND LANDLOK® OR PYRAMAT® TURF REINFORCEMENT MAT (OR EQUAL) TO ACCOMODATE MAXIMUM DESIGNDED FLOW DEPTH

2. PLACE 3 ANCHOR / m² (2 1/2 ANCHORS / Yd²) FOR CHANNELS



SILT-SIOP American Excelsion Company

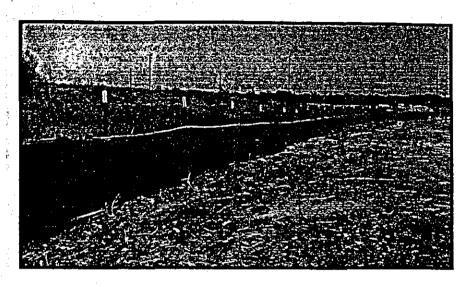
SEDIMENT CONTROL FENCING



Silt-Stop Fences are designed to reduce sediment run-off from disturbed soils into lakes, streams, streets or any sensitive areas. The specially

designed fabric allows for water movement through the fabric, while suspended soil particles settle behind the fence.

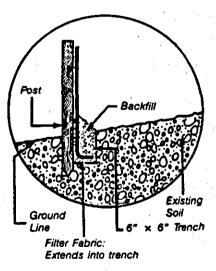
Due to various soil conditions and state specifications, American Excelsior Company offers a variety of fence constructions. You should check with your local representative for assistance in selecting your site-specific products.



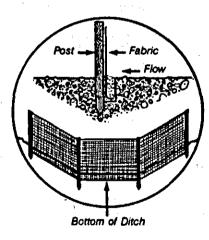
Silt-Stop Specifications and Installation Instructions:

Teneral installation instructions (consult your local representative for local specifications).

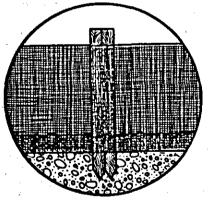
Slope Check



Ditch Check



Joining Fences



Place the end post of the second fence inside the end post of the first fence. Rotate both posts at least 180 degrees in a clockwise direction to create a tight seal with the fabric material.

Drive both posts about 10 inches into the ground and bury flap.

American Excelsior manufactures a very complete line of erosion and sediment control products. Please call us at our toll-free number: 1-800-777-SOIL (7645) for complete information on all of our products, or consult the reverse side for the location nearest you.



SEDIMENT LOG

The log that controls movement of silt and reduces water flow in critical area



Sediment Log Features

On site installations have shown Sediment Log's open core matrix does not deflect water flow or silt around the ends of the installation. Intimate soil contact with the Sediment Log and expansion of the Curlex wood fibers inside the log core offset undermining, overtopping, and blow outs.

✓ The Sediment Log outside is made up of a durable, open weave, containment mesh. The inside core is filled with 100% Curlex[®] Aspen excelsior wood fibers. The fibers are curled and have soft interlocking barbs that expand when wet. The fibers protrude through the containment fabric, allowing intimate contact with the soil conditions.

Available in 20" diameter and lengths of 7.5', 10' and 12'. Sediment Log is one of the best management practices (BMP) to meet NPDES requirements.

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CONSTRUCTION SPECIALTIES Since 1916

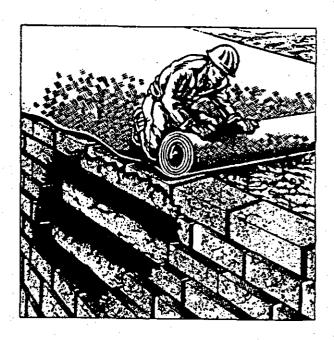


Amoco Fabrics and Fibers Company

EROSION CONTROL

Amoco's Geotextiles make retaining walls financially feasible. In fact, a geotextile retaining wall can be built for less than half the cost of a conventional wall. Woven geotextiles offer other significant advantages over conventional methods, such as simplified installation and construction, and the ability to use on-site backfill material.

Engineers like the fact that Amoco Geotextiles give them flexibility in design. Amoco reinforced geotextile walls can be designed using AASHTO, FHWA, NCMA and U.S. Forest Service design methods. Amoco's technical support resources can help you select the property values required for each.



Amoco 2006, 2016 and 2044 are all used for construction of reinforced walls. Each can be used in a wrapped-face configuration or with a variety of facing units. Amoco 2006 and 2016 are ideal for small or temporary walls. Amoco 2044 is prequalified and specified by manufacturers of popular modular block systems.

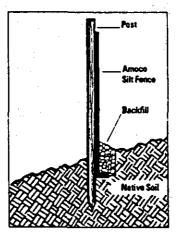
SEDIMENT CONTROL

Temporary silt fences perform a vital function for the construction industry. Because construction activity disturbs vegetation, topsoil is vulnerable to being washed away by rain. Without geotextile silt fences, sediment often ends up in streams, rivers and lakes, killing fish and other aquatic life.

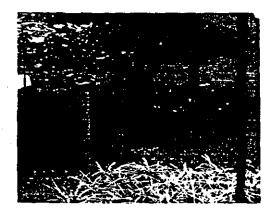
Amoco 2130 offers the high soil filtering efficiency and the lowest water flow rate to meet ASTM D5141 and VTM-51 requirements.

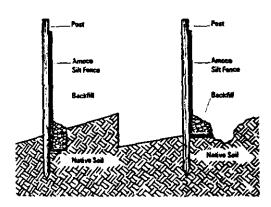
AR001359











Easy Installation

To install sin fence, simply drive stakes on site, attach Amoco Siit Fence fabric with stapler, backfill, and compact. An alternate method of installation is the use of preassembled silt fence. Posts are preattached to the fabric, allowing convenient installation. Simply unroll, stretch, and drive stakes

Note—If possible, silt fence should be installed in a 6" deep trench to prevent sediment flow underneath the fence. Make sure that all succorting posts are on the down slope side of the fencing.

Amoco Offers A Variety Of Silt Fence Fabrics To Accommodate A Wide Range Of Requirements.

Amoco Silt Fence Fabrics are designed specifically to reduce soil sediment run off from, or into, protected areas. They function in a manner similar to a sedimentation basin in which water is allowed to filter through the fabric while suspended soil particles settle to the ground. This restricts the loss of costly soil from the site while permitting the water to drain efficiently.

These fabrics are made of woven polypropylene yarns, which have been treated to resist degradation caused by exposure to sunlight. Polypropylene is one of the most inert textile polymers available and highly resistant to commonly encountered soil chemicals, mildew, and bacteria.

Style 2122 - This highly engineered silt fence product provides a unique combination of soil filtering efficiency and water flow rate.

Style 2125 - Combining efficiency, low flow rate, and economics, this material meets the AASHTO M-288-90 requirements for self-supported sediment control.

Style 2127 - This is Amoco's most economical fencing fabric, designed to meet the needs of the open-spec market.

Style 2130 - Offers the highest soil filtering efficiency, and the lowest flow rate to meet VTM-51 requirements.

Style 2155 - Same physical properties as 2125 but an attachment belt is added for those specifications which require a support at the top.

Style 1380 - Medium flow rate, high strength, premium Silt Fence with post attachment belt for quick and easy installation on supporting posts.

Style 1198 - High flow rate, very high strength, long lasting, with enhanced resistance to sunlight exposure.

The Source For Geotextila Solutions™



Amoco Fabrics and Fibers Company

AMOCO SILT FENCE FABRICS

A second of the	MINIMUM PH	YSICAL P	ROPER	TIES				
Physical Properties	Test Methods	2122	2125	2127	1380	1198	2130***	2155**
Grab Tensile,:bs.	A\$TM-D-4632	W120 F100	W100 F100	W95 F80	W175	W300 F200	W120 F120	W100 F100
Grab Elongation, %	ASTM-0-4632	15	15 ·	15	25	W30 F25	W15 F20	15
Mullen Burst, psi	ASTM-D-3786	275	275	250	300	450	340	275
Puncture, lbs.	ASTM-D-4833	65	50	30 -	80	120	60	: 60 ·
Trapezoidal Tear, Ibs.	ASTM-D-4533	50	50	60	50	W75 F65	W80 F80	50
UV Resistance ² , % ³	ASTM-D-4355	80	80	80	80	90	80	80

		HYDRAULIC	PROP	RTIES				1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	
AOS.	US Sieve Number	ASTM-D-4751	30/40	20/30	10/30	30/50	30/50	30/40	30/40
Permit	tivity, gal/min/ft ²	ASTM-D-4491	90	15	30	30	30	10	,15 =

All test methods are ASTM Standards. 2. Fabric conditioned per ASTM D-435. 3. Percent retained of minimum grab tensile after conditioning.
 With Woven Draw Tape. *** Has met VA & PA DOT Requirements

					PACKAGING									
آ	Dimensions		21	22	212	25	21	: 27	1380	-: 1198	-213	30***	21	55**
	Roll Width	Ft.	2	3	2	3	, 2	3	3.5	3	2	3	2.	3
	Rall Length	, Ft.	5100 to	6600	6000 t	o 7500	6000 t	o 7500	150	450	6000 to	7500	4500 t	o5400
	Roll Diameter	ln.	28	28	29	29	27	27	8	12	- 29	29	25	25
	Grass Weign:	Lbs	330	491	301	447	312	463	25	65	343	500	. 212	314
	Area	Sq. Yds	1133 to 1466	1700 to 2200	1333 to 1666	2000 to 2500	1333 to 1666	2000 to 2500	58	150	1333 to 1666	2000 to 2500	to 1200	1500 to 1800

	СН	TERIST					100	
Properties		 2122	2125	2127	1380	1198	2130***	2155**
Yarn Construction		 T/M	1/1	Ţ/Ţ	T/S	M/M	1/1	1/1
Color		BL/BL	8L/8L	BL/BL	G/BL	BL/BL	BL/BL	BL/BL

TEMPORARY SILT FENCE GUIDE SPECIFICATION

DESCRIPTION

This work shall consist of furnishing, installing, maintaining, and removing a temporary water permeable filter fence (silt fence) to remove suspended particles from the drainage water passing through it.

The quantity of temporary silt fence to be installed will be affected by the actual conditions which occur during the construction of the project. The quantity of temporary silt fence may be increased or decreased at the direction of the engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

MATERIAL REQUIREMENTS

Silt Fence: The silt fence shall be constructed of a minimum 36-in. wide geotextile securely fastened to posts. The geotextile shall be attached to the up-gradient side of the posts such that a 6-in. to 8-in. length of geotextile is left unattached at the bottom to be buried in soil. The silt fence shall be constructed to withstand the forces induced by sediment loading. When required, wire or another type of support shall be constructed between the geotextile and the posts to improve the load carrying capacity of the silt fence.

Geotextile: The geotextile shall be composed of synthetic fibers formed into a woven or nonwoven fabric. Woven geotextiles shall meet the property requirements provided in Table 4-1. Nonwoven geotextiles shall meet the property requirements provided in Table 4-2. The geotextile shall contain stabilizers and/or inhibitors to make the fibers resistant to deterioration resulting from exposure to sunlight or heat. Edges of the geotextile shall be finished to prevent the outer fibers from pulling away from the geotextile. The geotextile shall be free of defects or flaws which significantly affect its physical and/or filtering properties.

Fibers used in the manufacture of geotextiles shall be composed of at least 85 percent by weight polyolefins, polyesters, or polyamides. They shall be formed into a previous network of filaments or yarns which retain dimensional stability including selvages under normal handling, installation and service conditions. The geotextile shall be free of any treatment or coating which might adversely alter its physical properties after installation. Each geotextile roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes.

The geotextile shall be protected from the elements prior to installation. The geotextile shall not be exposed to temperatures greater than 140° F.

Posts: Posts shall be a minimum of 4 ft. long and pointed at one end. Wood or steel posts may be used. The post type selected shall be based on anticipated drainage conditions and silt loading. Maximum post spacing shall be between 4 ft and 6 ft depending on anticipated drainage conditions and silt loading. Soft wood posts shall be at least 3-in. in diameter, or nominal 2 in. x 4 in. and straight enough to provide a fence without noticeable misalignment. If oak posts are used, the size may be reduced to 1-1/2 in. x 1-1/2 in. with a tolerance of minus 1/8 in. providing the cross-sectional area is a minimum of 2.25 in². Steel posts shall be round, "U", "T", "L" or "C" shaped with a minimum weight of 0.75 lb/ft. Higher post weights may be required as directed by the engineer.

Support: When required, wire or another type of support shall be used to improve the load carrying capacity of the silt fence. Support is required for silt fence constructed with nonwoven geotextile. Support shall be at least 34-in. high and strong enough to support applied loads. The support shall be fastened securely between the geotextile and the post.

Prefabricated Fence: Prefabricated fence systems may be used provided they meet all of the above material requirements.

Fasteners: The geotextile may be attached to the posts using geotextile pockets, hems with cord, staples or nails. Wire staples shall be a No. 17 gauge minimum and shall have a minimum 0.75 in. wide crown and 0.5 in. long legs. Staples shall be evenly spaced with at least 4 per post. Nails shall be a minimum of 14 gauge, 1 inch long, with 0.75 in. button heads. Nails shall be evenly spaced with at least 4 per post.

CONSTRUCTION AND INSTALLATION REQUIREMENTS

Silt Fence: The contractor shall install silt fence in accordance with this specification and as shown in the contract drawings or as directed by the engineer. Silt fence construction shall be adequate to handle the stress due to sediment loading. Posts shall be installed at least 18-in. deep into the ground. Where an 18-in. depth is impossible to achieve, the posts should be adequately secured to prevent overturning of the fence due to sediment loading.

All geotextile splice joints shall be sewn. Silt fence splice joints shall be constructed with a minimum overlap of 18 in. as shown in Figure 4-1. The bottom geotextile edge of the silt fence shall be buried to a minimum depth of 6 in. such that no water flow can pass beneath the silt fence. The geotextile shall be buried as shown in Figure 4-2. When wire support fence is used, the wire shall also be buried a minimum of 2 in. and extend a maximum of 32 in. above the original ground surface.

Maintenance and Removal: The silt fence shall remain in place until the engineer directs that it be removed. The contractor shall maintain the silt fence until it is removed, and shall remove and dispose of soil accumulations at the silt fence when so directed by the engineer.

It is the contractor's responsibility to maintain the integrity of silt fences as long as necessary to contain sediment runoff. The contractor shall inspect all silt fences immediately after each rainfall and at least daily during prolonged rainfall. Any deficiencies shall be immediately corrected by the contractor. In addition, the contractor shall make a daily review of the location of silt fences or posts in areas where construction activities have changed the natural contour and drainage runoff to ensure that the silt fences are properly located for effectiveness. Where deficiencies exist, additional silt fences or posts shall be installed as directed by the engineer. The silt fence should be promptly repaired or replaced should it become damaged or otherwise ineffective.

Sediment deposits shall either be removed when the deposit reaches approximately 1/2 of the height of the silt fence or a second silt fence shall be installed as directed by the engineer. Silt fence which has been removed will remain the property of the contractor. Upon removal of the silt fence, the contractor shall remove and dispose of excess soil accumulations, dress the area to give a pleasing appearance and vegetate all bare areas in accordance with the contract agreements.

METHOD OF MEASUREMENT

Silt Fence: The quantity of temporary silt fence to be paid for will be the actual number of linear feet of silt fence, measured in place from end post to end post of each separate installation, which has been completed and accepted.

Sediment Removal: Removed sediment will be measured by the cubic yard.

BASIS OF PAYMENT

Silt Fence: Silt fence will be paid for per linear foot which shall be full compensation for completing the work specified. Such payment shall be full compensation of furnishing all materials, erecting, maintaining, and removing the fence.

Sediment Removal: Removing the accumulated silts shall be paid for by cubic yards. Dressing and grassing will be paid for by the acre.

TABLE 4-1

PHYSICAL REQUIREMENTS FOR

WOVEN GEOTEXTILE 1,2,3

Property	Units	Standard Silt Fence	High	Test
· · · · · · · · · · · · · · · · · · ·		* .	Performance Silt Fence ⁵	, _`Method
Tensile Strength	lb ·	90	100	ASTM D 4632
Elongation	%	50	50	ASTM D 4632
Permittivity	gal/min/ft²	15	90	ASTM D 4491
Apparent Opening Size	U.S. Standard Sieve No.	20	30	ASTM D 4751
Ultraviolet Stability ⁴	%	80	80	ASTM D 4355

Notes:

- 1. Conformance of geotextiles to specification property requirements shall be determined according to ASTM D 4759, "Practice for Determining the Specification Conformance of Geosynthetics".
- 2. Contracting agency may require a letter from the manufacturer certifying the geotextile meets specification requirements.
- 3. All numerical values, except values for elongation, represent minimum average roll value (i.e., average of test results from any sampled roll in a lot shall meet or exceed the minimum average values in the table) in weaker principal direction. Values for elongation represent maximum average roll values. Stated values are for non-critical, non-severe conditions. Lot sampled according to ASTM D 4354, "Practice for Sampling Geosynthetics for Testing".
- 4. Percent of minimum tensile strength (ASTM D 4632, "Test Method for Breaking Load and Elongation of Geotextiles [Grab Method]") retained after weathering per ASTM D 4355, "Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)" for 500 hours.
- 5. High performance silt fence should be used on projects requiring high flow rates through the silt fence or on projects requiring higher sediment retention.

TABLE 4-2

PHYSICAL REQUIREMENTS FOR NONWOVEN GEOTEXTILE 1,2,3

Property	Units	Standard	Test
		Silt Fence	Method
Tensile Strength	lb	90	ASTM D 4632
Elongation	%	50	ASTM D 4632
Permittivity	gal/min/ft ²	15	ASTM D 4491
Apparent Opening Size	U.S. Standard Sieve No.	70	ASTM D 4751
Ultraviolet Stability ⁴	%	80	ASTM D 4355

Notes:

- 1. Conformance of geotextiles to specification property requirements shall be determined according to ASTM D 4759, "Practice for Determining the Specification Conformance of Geosynthetics".
- 2. Contracting agency may require a letter from the manufacturer certifying the geotextile meets specification requirements.
- 3. All numerical values represent minimum average roll value (i.e., average of test results from any sampled roll in a lot shall meet or exceed the minimum average values in the table) in weaker principal direction. Stated values are for non-critical, non-severe conditions. Lot sampled according to ASTM D 4354, "Practice for Sampling Geosynthetics for Testing".
- 4. Percent of minimum tensile strength (ASTM D 4632, "Test Method for Breaking Load and Elongation of Geotextiles [Grab Method]") retained after weathering per ASTM 4355, "Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)" for 500 hours.

FIGURE 4-1 SILT FENCE SPLICE JOINT

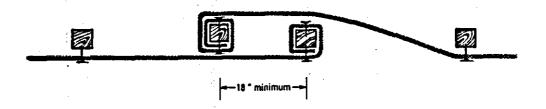
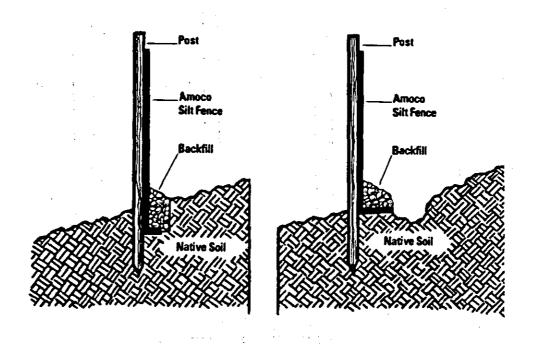
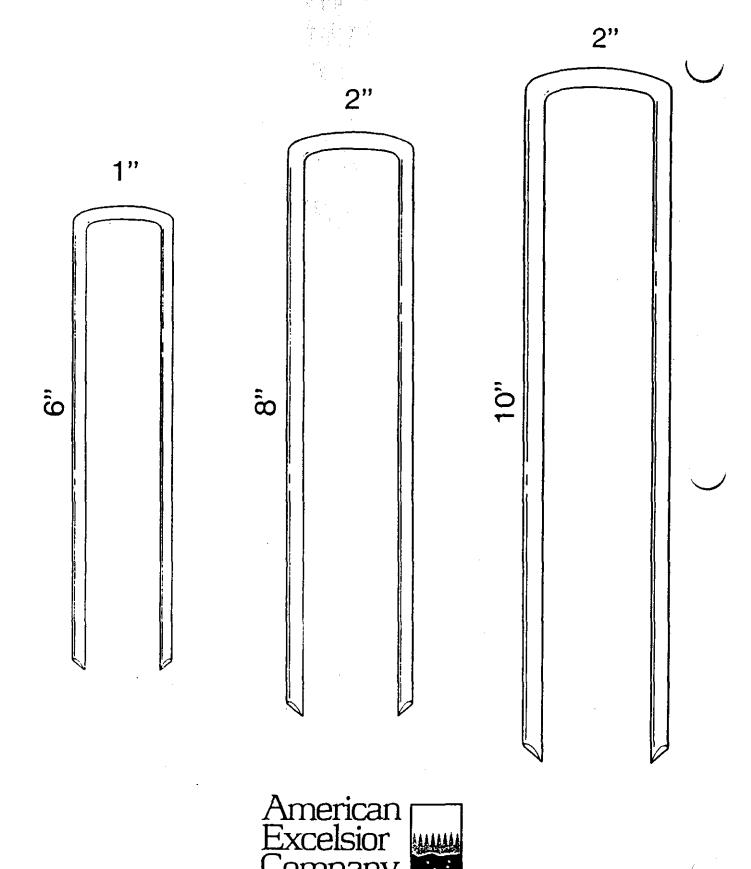


FIGURE 4-2 SILT FENCE GEOTEXTILE BURIAL





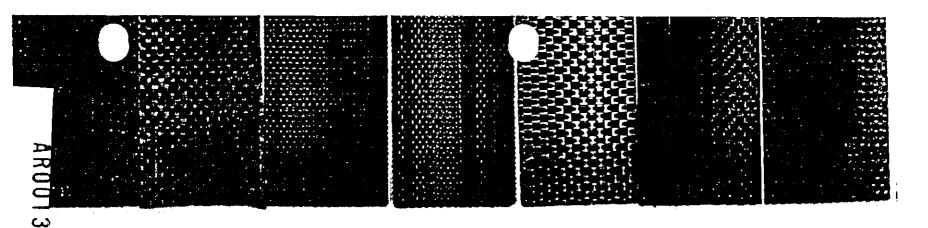
A COMPLETE LINE OF NONWOVEN GEOTEXTILES THAT HELP YOU DESIGN WITH CONFIDENCE



		NONWO		EOTEX						
PROPERTIES*	TEST METHOD	UNITS	4538	4545	4551	4553	4557	4561	4597	4599
PHYSICAL										
Grab Tensile Strength	ASTM 0-4632	ibs.	80	90	150	200	_ 275	325	120	90
Grab Tensile Elongation	ASTM-0-4632	3.3	50	50	50	50	50	50	50	50
Mullen Burst	ASTM-D-3786) osi	175	225	315	400	600	750	250	200
Puncture	ASTM-0-4833	ibs.	40	65	90	130	175	230	75	60
Trapezoid Tear	ASTM-0-4533	ibs.	25	45	65	80	115	130	45	35
UV Resistance	ASTM-0-4355) ₃	70	70	70	70	70	- 70	70	70
HYORAULIC										
Apparent Opening Size (AOS)	ASTM-D-4751	US Sieve		70	100	100	100	100		
Permittivity	ASTM-D-4491	sec1		2.5	1.9	15	1.1	.07		
Flow Rate	ASTM-0-4491	Gail, minuft.4		175	130	80	60	50	·	
PAVING										
t Retention	TX DOT 3099	gal sq. yd.	.20						0 35	0.25
Asphalt Ratention	TX DOT 3099	sq. ft.	2.8						.4.5	3.5
One Side Heat-Bonced			χ						Х	Х
PACKAGING										
Roll Width		i t.	12.5	15	15	15	15	15	12 5	12.5
Rolf Length		45.	450	420	300	240	165	120	300	450
Bross Weight		-CS.	170	210	205	215	220	220	170	175
Area		53. /CS.	625	700	500	100	275	200	416	6 25
SUGGESTED APPLICATIONS										
Erosion Control					. X	ζ.	х			
Grainage		*	X	X	X					
Asphalt Cuertay/Paving			X						Х	χ
Paitroad Stabilization	, ·		/			; <u>(</u>	X	. X		1

Minimum Average Roll Value

The information contained Berein is furnished without charge or obligation and the recipient assumes all responsibility for its use. Because conditions of use and bandling may vary and are beyond our control, we make no representation about, and are not responsible or liable for, the conditions of use and bandling may vary and are beyond our control, we make no representation about, and are not responsible or liable for, the conditions of use and information or the performance of any product. Any specifications, properties or applications listed herein are as information only and in no way modify, amend, enlarge or create any warranty. Nothing contained herein is to be construed as not reas a recommendation to infringe any patent.



AMOCO WOVEN CONSTRUCTION FABRICS

Property	Test Method	Units	2125	1380 Silt Stop*	1199	1198	2006	2002	2000	2090
Grab Tensile	ASTM-D-4632	lbs.	WARP 110 FILL 100	WARP 175	WARP 350 FILL 230	WARP 300 FILL 200	300	200	140	90
Grab Elongation	ASTM-D-4632	%	15	25	WARP 34 FILL 32	WARP 30 FILL 23	15	15	15	15
Mullen Burst	ASTM 3786	psi	275	300	510	450	600	400	350	200
Puncture	ASTM-D-4833	lbs.	60	80	140	120	120	90	70	30
Trapezoidal Tear	ASTM-D-4533	lbs.	50	50	WARP 75 FILL 65	WARP 75 FILL 65	120	75	45	30
UV Resistance	ASTM-D-4355*	%**	70	70	90	90	70	70	70	70 (200hrs.)
Abrasion Resistance (Strength retained)	ASTM-D-3884 (1000 cycles-CS17 wheel)	lbs.	n/a	n/a	55	55	n/a	n/a	n/a	n/a
Apparent Opening Size (AOS)	ASTM-D-4751	US Sieve Number	20/30	30/50	70/100	30/50	30/70	30/70	30/70	30/70
Permittivity	ASTM-4491	gal/min/ft² sec'	15 .2	30 .4	.04	50 .5	.02	.04	.04	.02

^{*}Fabric conditioned as per ASTM-D-4355. **Percent of minimum grab tensile after conditioning.

Minimum Roll Average values. Nonfunctional properties such as color, weight, and thickness are not shown.

Packaging	21	25	13 Sin S		1199	1198	2006		2002		20	000	2090
Roll Width (ft.)	2	3	3.5	2.5	6	6	14.5	12.5	14.5	18	12.5	18	12.5
Roll Length (ft.)	1500	1500	150	150	450	450	310	504	435	350	504	350	720
Roll Diameter (in.)	8	8	8	8	12	12	12	13	12	11	11	10	13
Gross Weight (lbs.)	60	90	25	18	140	140	220	220	220	220	140	140	160
Area (sq. yd.)	333	500	58	42	300	300	500	700	700	700	700	,	1000

The information present a nerein, white not guaranteed, is to the best of our knowledge true and accurate and the last assumes all responsibility for its use. No warranty or guarantee expressed or implied is in a serin regarding the performance of any product, since the manner of use and handling are beyond our control. Nothing contained herein is to be construed as a manner of use and handling are beyond our control. Nothing contained herein is to be construed as a manner of use and handling are beyond our control.

DRAINAGE GEOTEXTILES GUIDE SPECIFICATION

DESCRIPTION

This work shall consist of furnishing and placing a geotextile for the following drainage applications: edge of pavement drains, interceptor drains, wall drains, recharge basins, and relief wells. The quantities of drainage geotextiles as shown on the plans may be increased or decreased at the direction of the engineer based on construction procedures and actual site conditions that occur during construction of the project. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

MATERIAL REQUIREMENTS

Drainage geotextiles shall meet the physical requirements of Table 2-1. Fibers used in the manufacture of drainage geotextiles shall consist of a material composed of at least 85 percent by weight polyolefins, polyesters, or polyamides. The geotextile and the threads used in sewing geotextiles shall be resistant to chemical attack, rot and mildew. The geotextile shall have no tears or defects which adversely alter its physical properties.

CONSTRUCTION AND INSTALLATION REQUIREMENTS

Shipment and Storage: The geotextile shall be kept dry and wrapped such that it is protected from the elements during shipping and storage. At no time shall the geotextile be exposed to ultraviolet light for a period exceeding fourteen days. Geotextile rolls shall be stored in a manner which protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover. The geotextile shall be labeled as per ASTM D 4873, "Guide for Identification, Storage, and Handling of Geotextiles".

Geotextile Placement: Prior to placement of the geotextile, the surface will be prepared to a smooth condition free of debris, depressions, or obstructions which may damage the geotextile. The drainage geotextile shall be placed loosely (not taut) with no wrinkles or folds. Care will be taken to place the geotextile in intimate contact with the soil so that no void spaces occur between the geotextile and the trench. The geotextile shall be overlapped twelve inches or the full width of the trench, whichever is less, at the top of the trench. Additional overlap or anchoring may be required as determined by the engineer. The upstream geotextile shall be overlapped over the downstream.

Care shall be taken during construction to avoid contamination of the geotextile with soil or other material. Contaminated geotextile shall be removed and replaced at the contractor's expense. Any damaged geotextile shall be repaired by placing a patch extending three feet in all directions beyond the damaged area. Damaged geotextiles shall be replaced at no expense to the owner.

Drainage Aggregate Placement: Drainage aggregate shall be placed on the geotextile in a manner which prevents damage to the geotextile. Placement of drainage aggregate shall proceed immediately following placement of the geotextile. The geotextile shall be covered with a minimum of 12 in. of loosely placed aggregate prior to compaction. The aggregate should be compacted with vibratory equipment to a minimum of 95 percent standard Proctor density as determined in accordance with AASHTO T99, "Moisture-Density Relations of Soils Using a 5.5 lb [2.5 kg] Rammer and a 12-in. [305 mm] Drop".

METHOD OF MEASUREMENT

Geotextile: The geotextile shall be measured in square yards as computed from the payment lines shown on the plans or from the payment lines established in writing by the engineer. This excludes seam overlaps.

BASIS OF PAYMENT

Geotextile: The accepted quantities of geotextiles shall be paid for at the contract unit price per square yard in place.

Payment will be made under:

Pay Item Pay Unit

Drainage Geotextile Square Yard

TABLE 2-1

PHYSICAL REQUIREMENTS DRAINAGE GEOTEXTILES^{1, 2, 3}

				
Property	Units	Class A4	Class B ⁵	Test Method
Tensile Strength	11	180	80	ASTM D 4632
Elongation	%	N/A	N/A	ASTM D 4632
Seam Strength ⁶	lbs :	160	70	ASTM D 4632
Puncture Strength	lb .	80	25	ASTM D 4833
Burst Strength	lb/in²	290	130	ASTM D 3786
Trapezoid Tear	lb	50	25	ASTM D 4533
Apparent Opening Size ⁷	U.S. Standard Sieve	70	70	ASTM D 4751
Permittivity	gal/min/ft ²	50	50	ASTM D 4491
Ultraviolet Stability ⁸	%	70	70	ASTM D 4355

Notes

 Acceptance of geotextile material shall be determined according to ASTM D 4759, "Practice for Determining the Specification Conformance of Geosynthetics".

- 2. Contracting agency may require a letter from the manufacturer certifying its geotextiles meet specification requirements.
- 3. All numerical values represent minimum average roll values (i.e., average of test results from any sampled roll in a lot shall meet or exceed the minimum values) in the weaker principal direction. Lot shall be sampled according to ASTM D 4354, "Practice for Sampling of Geosynthetics for Testing".

(Table 2-1 continued)

- 4. Class A Drainage applications are for geotextile installations where applied stresses are more severe than Class B applications; i.e., very coarse sharp angular aggregate is used, a minimum compaction energy greater than 95 percent of AASHTO T99, "Moisture-Density Relations of Soils Using a 5.5 lb [2.5 kg] Rammer and a 12-in. [305 mm] Drop", is specified, compaction of lifts less than 12 inches thick over the geotextile, or depth of trench is greater than 10 feet.
- 5. Class B Drainage applications are for geotextile installations where applied stresses are less severe than Class A applications; i.e., smooth graded surfaces having no sharp angular projections, and no sharp angular aggregate, a minimum compaction energy less than or equal to 95 percent AASHTO T99, "Moisture-Density Relations of Soils Using a 5.5 lb. [2.5 kg] Rammer and a 12-in. [305 mm] Drop", is specified and trenches are less than 10 feet in depth.
- 6. Applicable only if seams are required by the engineer. Values apply to both field and factory seams.
- 7. Values represent minimum recommended apparent opening sizes. Sitespecific apparent opening size values to be selected by the design engineer based on site conditions and soils.
- 8. Percent of minimum tensile strength (as measured in accordance with ASTM D 4632, "Test Method for Breaking Load and Elongation of Geotextiles") retained after weathering per ASTM D 4355, "Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)" for 150 hours.

EROSION CONTROL GEOTEXTILES GUIDE SPECIFICATION

DESCRIPTION

This work shall consist of furnishing and installing erosion control geotextiles beneath rip rap, gravel, gabions or other erosion protection material in accordance with the lines, grade, design and dimensions shown in the contract drawings and as specified herein.

The quantities of erosion control geotextiles as shown on the contract drawings may be increased or decreased at the direction of the engineer based on construction procedures and actual site conditions that occur during construction of the project. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

MATERIAL REQUIREMENTS

Geotextile: The geotextiles shall be composed of synthetic fibers formed into a woven or nonwoven fabric. Fibers used in manufacture of the geotextile shall be composed of at least 85 percent by weight polyolefins, polyesters, or polyamides. They shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvages. These materials shall conform to the requirements of Table 3-1. The geotextile shall contain stabilizers and/or inhibitors to make the fibers resistant to deterioration resulting from exposure to sunlight or heat. The geotextile shall be free of defects or flaws which significantly affect its physical and/or filtering properties.

Gravel and Rip rap: Where rip rap erosion protection material is required, the rip rap shall conform to the grain size requirements and thickness provided in the contract documents. A 6-in, thick lift of gravel shall be placed between the geotextile and the rip rap in those locations where the minimum rip rap size is greater than or equal to 4-in, in diameter. Gravel and rip rap specific gravity shall not be less than 2.65. The gravel shall meet the following gradation requirement:

D₁₅ (gravel) <[D₈₅ (rip rap)/5]

Where D₁₅ and D₈₅ are soil particle sizes of which 15 percent and 85 percent by weight respectively are smaller. Values of D₁₅ and D₈₅ are obtained from a straight line approximation of the soil particle size distribution as determined in accordance with ASTM D 422 "Test Method for Particle-Size Analysis of Soils".

CONSTRUCTION INSTALLATION REQUIREMENTS

Geotextile Shipment and Storage: The geotextile shall be kept dry and wrapped such that it is protected from the elements during shipping and storage. At no time shall the geotextile be exposed to ultraviolet light for a period exceeding fourteen days. The geotextile shall be labeled as per ASTM D 4873, "Guide for Identification, Storage, and Handling of Geotextiles". Rolls shall be stored in a manner which protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover.

Geotextile Placement: The geotextile shall be placed on a smooth graded surface approved by the engineer. The geotextile shall be placed in such a manner that it will not excessively stretch or tear upon placement of the overlying materials. Care should be taken to place the geotextile in intimate contact with the soil such that no void spaces exist between the underlying soil and the geotextile. Anchoring of the geotextile shall be accomplished through the use of key trenches or aprons at the crest and toe of slope.

Geotextile sheets shall be joined by either sewing or overlapping. All overlaps and seams shall be subject to the approval of the engineer. Overlapped sheets shall have a minimum overlap of 18 in. except where placed underwater where the overlap shall be a minimum of 3 ft. Overlaps shall be constructed with the upstream sheet placed over the downstream sheet or the upslope sheet placed over the downslope sheet. All overlaps shall be pinned on 3-ft. centers to hold the overlap in place during stone placement. Pins are recommended to be 3/16-in. diameter, 18-in. long steel pins pointed at one end and fitted with a 1.5-in. diameter washer at the other.

Care shall be taken during construction to avoid contamination of the geotextile during construction. Contaminated geotextile shall be removed and replaced at the contractor's expense. Damaged geotextile shall be removed or repaired as directed by the engineer at no cost to the owner. A geotextile patch may be placed over damaged areas if approved by the engineer. The patch shall extend 3 ft. beyond the perimeter of the tear or damage.

Gravel and Rip rap: Gravel and rip rap placement shall begin at the toe and proceed up the slope. Rip rap shall not be dropped onto the geotextile from a height of more than 1 ft. Gravel shall not be dropped onto the geotextile from a height exceeding 3 ft. Any geotextile damaged during placement of rip rap or gravel shall be replaced as directed by the engineer at the contractor's expense. In underwater applications, the geotextile and required thickness of rip rap shall be placed the same day.

METHOD OF MEASUREMENT

Geotextile: The geotextile shall be measured by the number of square yards computed from the payment lines shown on the contract drawings or from payment lines established in writing by the engineer. This excludes seams and overlaps but shall include geotextiles used in the crest and toe of slopes. Slope preparation, excavation and backfilling, bedding, and cover material are separate pay items.

BASIS OF PAYMENT

Geotextile: The accepted quantities of geotextile shall be paid for per square yard in place.

Payment will be made under:

Pay Item

Pay Unit

Erosion Control Geotextile

Square Yard

TABLE 3-1

PHYSICAL REQUIREMENTS - EROSION CONTROL GEOTEXTILES^{1, 2, 3}

Property	Units	Class S4	Class A ⁵	Class B ⁶	Test Method
Tensile Strength	lb	500	200	90	ASTM D 4632
Elongation	%	15	15	15	ASTM D 4632
Seam Strength ⁷	lb	300	180	80	ASTM D 4632
Puncture Strength	lb	140	80	40	ASTM D 4833
Burst Strength	lb/in²	1350	320	140	ASTM D 3786
Trapezoid Tear	lb	300	50	30	ASTM D 4533
Permittivity	sec ⁻¹	0.15	.5	.5	ASTM D 4491
Ultraviolet Stability % ⁸	%	70	70	70	ASTM D 4355
Apparent Opening Size ⁹	U.S. Standard Sieve	50	70	70	ASTM D 4751

Notes:

- 1. Conformance of geotextiles to specification property requirements shall be based on ASTM D 4759, "Practice for Determining the Specification Conformance of Geosynthetics".
- 2. Contracting agency may require a letter from the manufacturer certifying that its geotextiles meet specification requirements.
- 3. All numerical values represent minimum average roll values (i.e., average of test results from any sampled roll in a lot shall meet or exceed the minimum values) in a weaker principal direction. Lot sampled according to ASTM D 4354, "Practice for Sampling of Geosynthetics for Testing".

(Table 3-1 continued)

- 4. Class S erosion control geotextiles are recommended for extremely severe installations such as those encountered when rip rap weighing more than 250 lbs. is used. A gravel blanket is recommended between the rip rap and the geotextile to lessen the severity of construction damage. Seaming as opposed to overlapping is recommended. Field trials are recommended to demonstrate that the geotextile is not damaged by construction activities.
- 5. Class A erosion control geotextiles are recommended for severe installation conditions. As a general guideline, for Class A geotextiles the drop height of rip rap weighing less than 250 lbs. should be less than 3 ft. Rip rap weighing more than 250 lbs. should be placed from a drop height of less than 1 ft. unless field trials demonstrate that this construction activity does not damage the geotextile.
- 6. Class B erosion control geotextiles are recommended for less severe installation conditions. As a general guideline, for class C geotextiles the drop height of rip rap weighing 250 lbs. or less should be less than 3 ft. when a gravel cushion is used or less than 1 ft. if no gravel cushion is used.
- 7. If seams are required by the engineer. Values apply to both field and factory seams.
- 8. Percent of minimum tensile strength (ASTM D 4632, "Test Method for Breaking Load and Elongation of Geotextiles" 'Grab Method') retained after weathering per ASTM 4355, "Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)" for 500 hours.
- 9. Values represent minimum recommended apparent opening size. Sitespecific apparent opening size values shall be selected by design engineer based on site conditions and soils.

APPENDIX 4

Soil Stockpile Area Information

VENDOR INFORMATION

Pre-cast Concrete Soil Stockpile Walls

"Precast Concrete Containment Bin Walls"

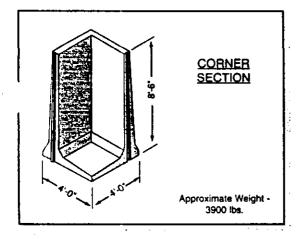
FOR THE HANDLING, CONTAINMENT AND STORAGE OF:

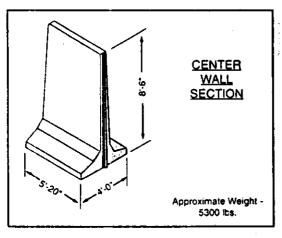
- * Recycled glass, plastics, aluminum or paper product
- * Anti-skid and salt for roads and parking lots
- * Ferrous and non ferrous scrap metals
- * Topsoil and mulch materials for landscaping
- * Compost and sludge
- * Construction/demolition debris, stone, sand and gravel

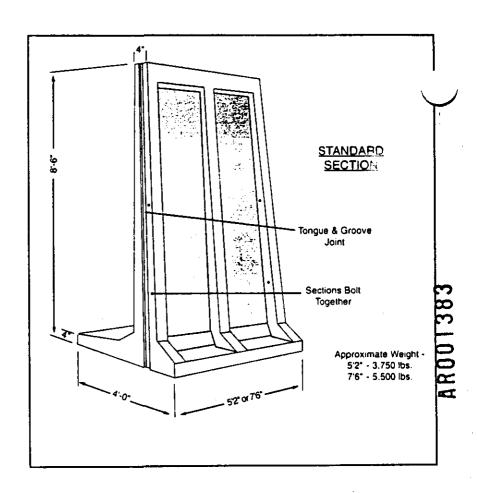
ADDITIONAL USES INCLUDED ARE:

- * Retaining walls
- * Privacy screens, site and noise barriers
- * Containment bin walls for retrofitting existing buildings







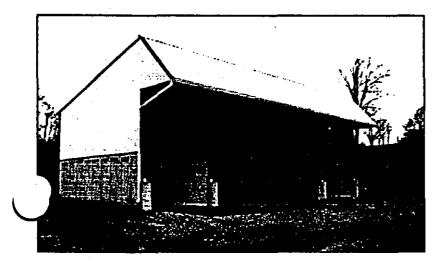




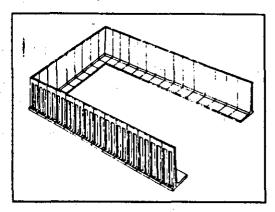
Sollenberger Silos Corp.

Site selection and project design assistance is available

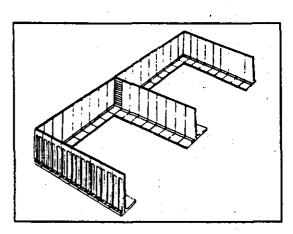
- * Standard size wall panels are manufactured and, in stock, ready for immediate delivery
- * A typical installation can be assembled at your job site in one (1) day
- * There is no construction waste or mess to clean up
- * Installations can be expanded or relocated to meet your future needs
- * Used panels retain an excellent resale and reuse value



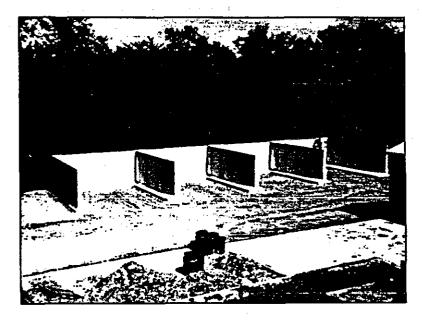
Single Bay Containment Bin







Multiple Bay Containment Bin





Sollenberger Silos Corp.

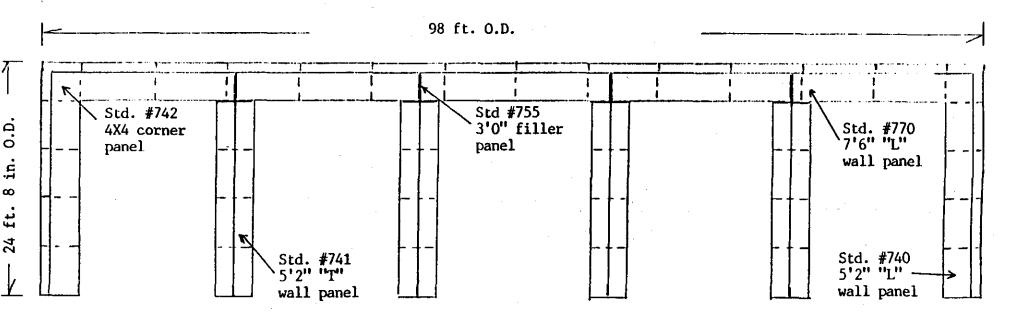
2294 Molly Pitcher Hwy. • Chambersburg. PA 17201 • (717) 264-9588 • FAX: (717) 264-2677

Contact Mike Hair, Product Sales Manager

"TYPICAL Five (5) bay wall system

approx. 1,000 cu.yds. storage capacity

** SOLLF GER SILOS CORP. - "PRECAST CONCRETE WALL PANELS"
P.O.L N
CHAMBERSBURG, PA 17201



Materials list needed to assemble the "TYPICAL" five (5) bay bin

wall panels 8 ea.- Std. #740 16 ea.- Std. #741 wall panels wall panels 2 ea.- Std. #742 4X4 corner 3'0" wall panels 4 ea.- Std. #755 filler 11.11 7'6" 12 ea.- Std. #770 wall panels 21 sets - Bolts, nuts & washers for outside wall

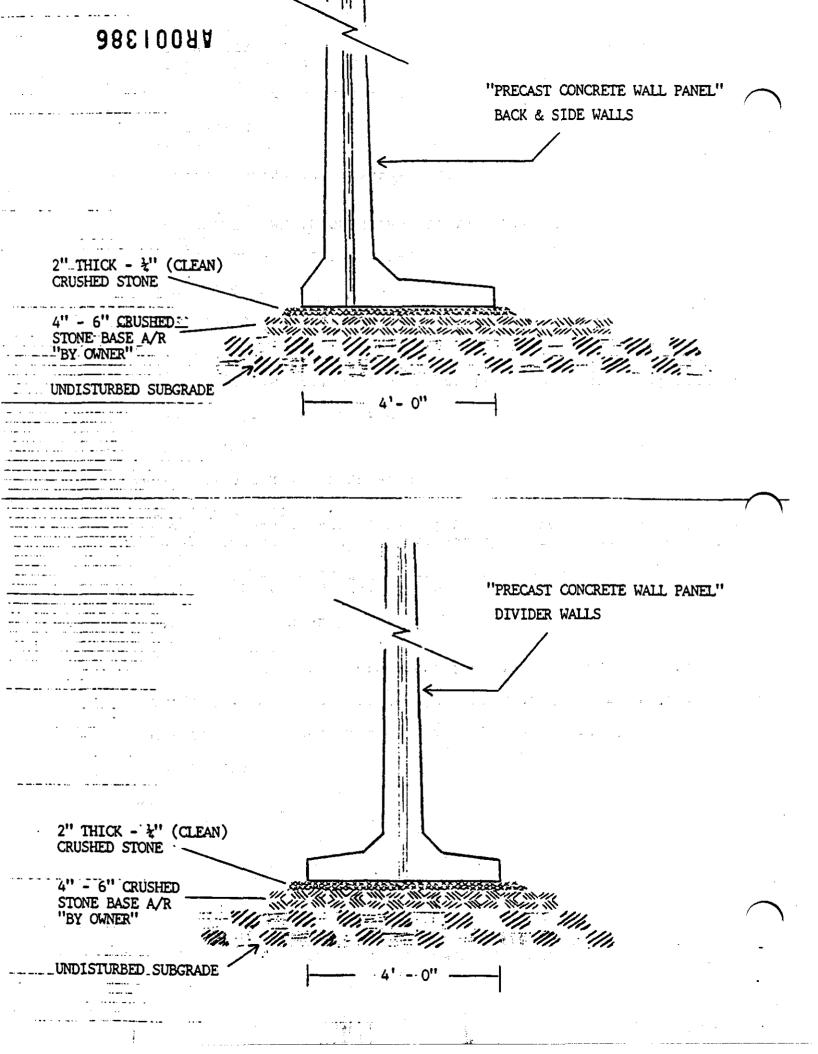
5 ea.- flatbed loads of freight to job site

Purchase and installation options

* Customer pick up FOB production plant located in Chambersburg, PA

* Supplied and delivered to your job site - customer and/or general contractor unload and install

* Supplied, delivered and installed on a prepared area by our experienced staff



"CHASE" PRECAST CONCRETE PANEL MANUFACTURING AND USE SPECIFICATIONS

PART 1 - GENERAL

1.01 REFERENCES

- A. U.S.D.A. Soil Conservation Services Standard 313.
- B. ACI 318 Building Code Requirements for Reinforced Concrete'
- C. Nitterhouse Concrete Products, Inc. engineering and design calculations.

1.02 MANUFACTURE'S QUALIFICATIONS

- A. Ten (10) years regularly engaged in the development and manufacturing of the "Chase" Precast Concrete Panel.
- B. Fully accredited National Precast Concrete Association (NPCA) certified manufacturing facility in accordance with NPCA Qualifontrol Manual.

PART 2 - MANUFACTURED FOR THE FOLLOWING USES

2.01 AGRICULTURAL

- A. Eunker silo feed storage systems.
- B. Animal waste storage systems for liquid and dewatered manure.

2.02 COMMERCIAL/INDUSTRIAL

A. Bulk storage containment bin walls.

ASH AND COAL
SALT
AGGREGATES - SAND AND GRAVEL
SLUDGE
RECYCLING - METAL, GLASS, PAPER, AND PLASTIC
COMPOSTING

B. Liquid storage and treatment tank walls.

WATER WASTEWATER

C. Retaining and barrier walls.

PRIVACY/SECURITY WALLS EARTH RETAINAGE BULK HEADS

PART 3 - CONCRETE DESIGN

- 3.01 CONCRETE UNIT WEIGHT OF 150 PCF
- 3.02 AIR ENTRAINED CONCRETE 6% +/-1 1/2%
- 3.03 WATER/CEMENT RATIO .40
- 3.84 COMPRESSIVE STRENGTH MINIMUM AT 28 DAYS; 5,888 PSI

PART 4 MANUFACTURING PRODUCTS

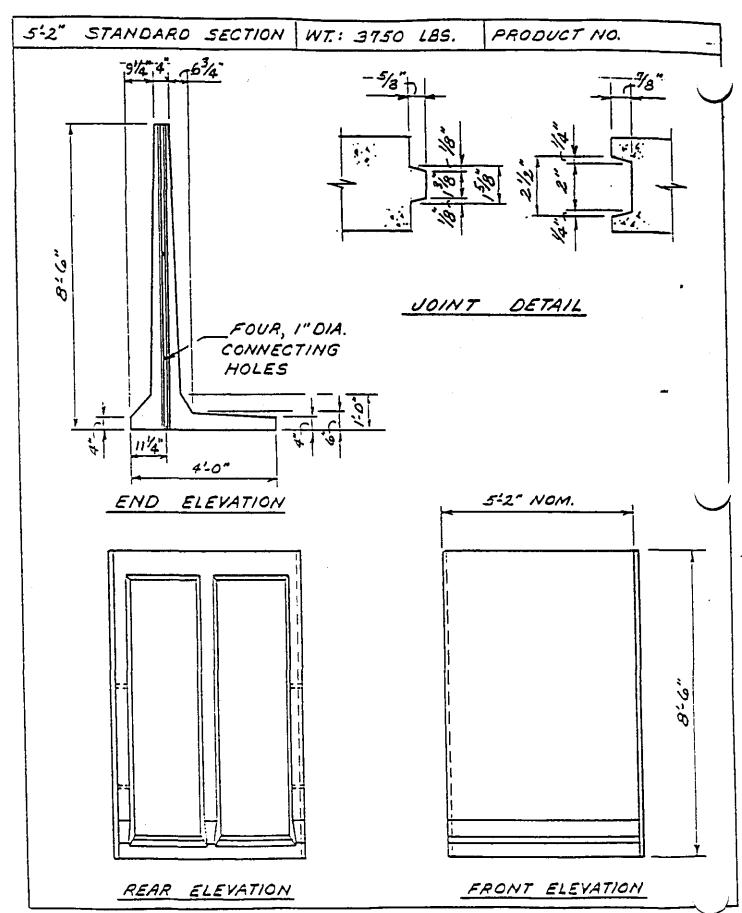
- 4.01 CONCRETE MATERIALS MEETING THE FOLLOWING
 - A. ASTM C150 CEMENT TYPE III
 - B. ASTM C33 AGGREGATES
 - C. ASTM D1411 WATER
 - D. ASTM C260 AIR ENTRAINING AGENT
 - E. ASTM C494 SUPERPLASTICIZER
- 4.02 REINFORCEMENT MATERIALS MEETING THE FOLLOWING
 - A. ASTM A615 DEFORMED STEEL BARS, GRADE 60

ART 5 SYSTEM DESIGN AND ERECTION

- 5.01 PANEL SYSTEMS CAN BE DESIGNED, DELIVERED, AND ERECTED BY TRAINED, EXPERIENCED COMPANY PERSONNEL.
- 5.02 CONSTRUCTION JOINTS OF PANELS CAN BE SEALED WITH AN APPROPRIATE SEALANT WHERE APPLICABLE.

 Note: Consult Engineering/Design Department for details.
- 5.03 FIELD OR FACTORY MODIFICATIONS TO PANELS MAY BE MADE.

 Note: Engineering/Design Department must be consulted prior to making or requesting changes.





Sollenberger Silos Corp.

A Nitterhouse Company
Box N. Chambersburg, PA 17201
A Products of Quality Concrete Products Since 1923

AR001389

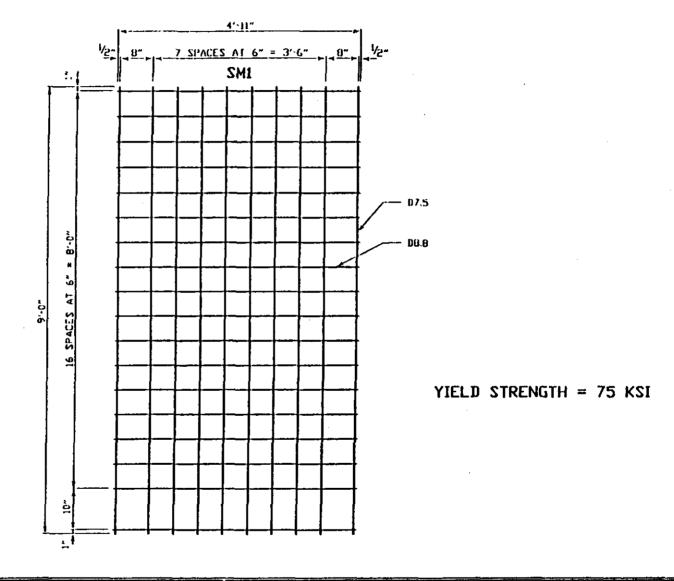
DATE:

PRODUCT NO. 0743 5'-2" STANDARD SECTION - M.S. REINE'G. (USE FOR "S" REINF'S AS WELL) 5MI NO. 5 BAR CENT BENT GR. 60 (3) GRADE 75 NO. 5 BAR BENT GR.60 (3) BENT 5MI Gast 75 SM2 GRACE 75 NOTE:

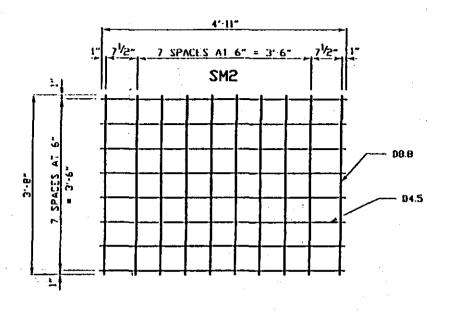
NOTE: ALL REINFORCING TO HAVE 11/2" COVERAGE.

AR001390

DATE: 2/11/98

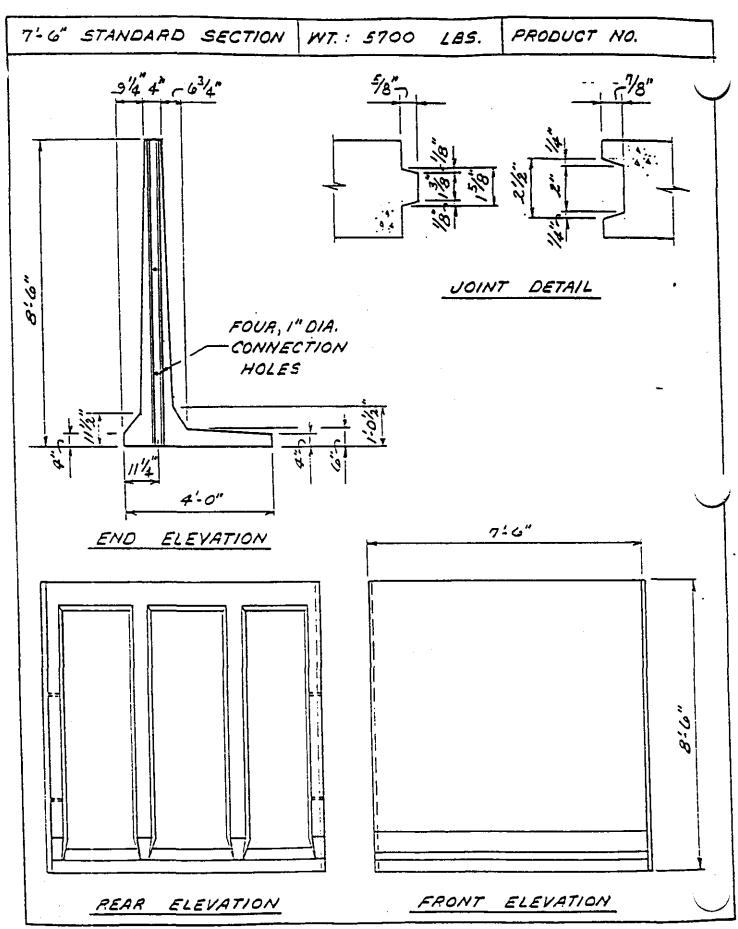


ISSUE	DATE	ISSUE	DATE	SILO MAT		
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FER FERN BUILDING		FOR REVISED PRODUCTION 🛕		PLANT HARDWARE		
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FOR PRODUCTY	8/11/98	<u> </u>		SMI		
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YIELD STRENGTH = 75 KSI

ISSUE	DATE	ISSUE	DATE	SILO MAT		
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FOR FORM DUDLBING		FOR REVISED PRODUCTION (3)	ļ	PLANT HARDWARE and		
FOR APPROVAL						
FOR PRODUCTION	E/11/98			SM		
FOR REVISED PRIDUCTION						



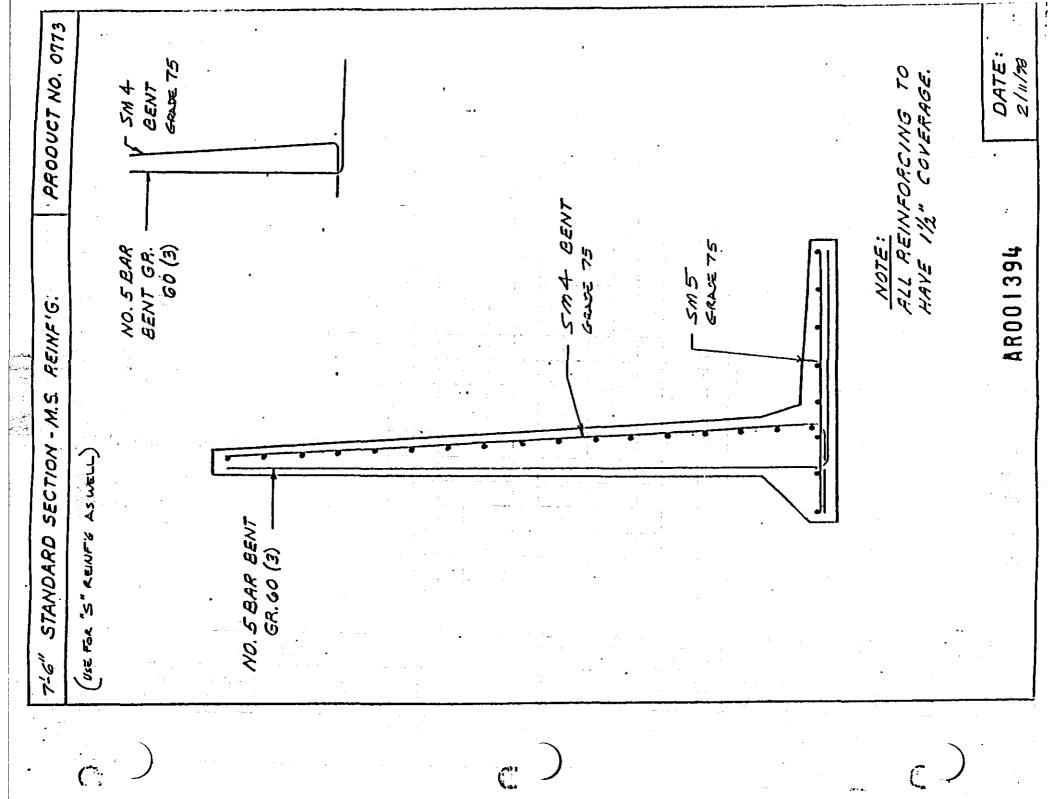


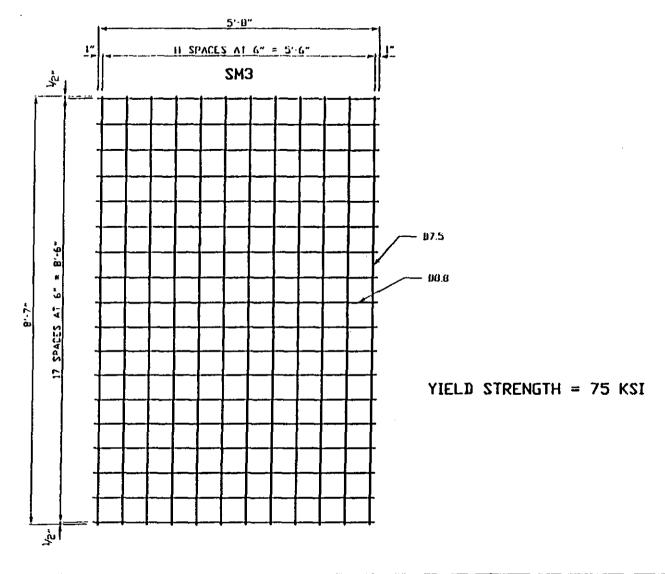
Sollenberger Silos Corp.

A Nitterhouse Company
Box N. Chembersburg, PA 17201

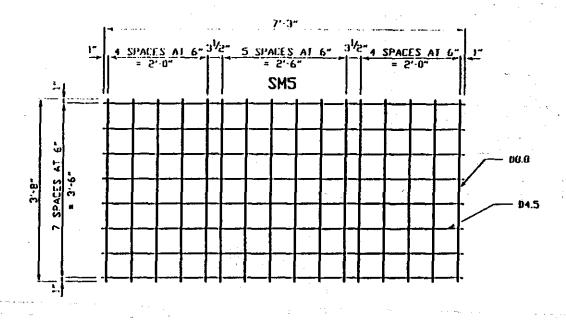
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DATE:





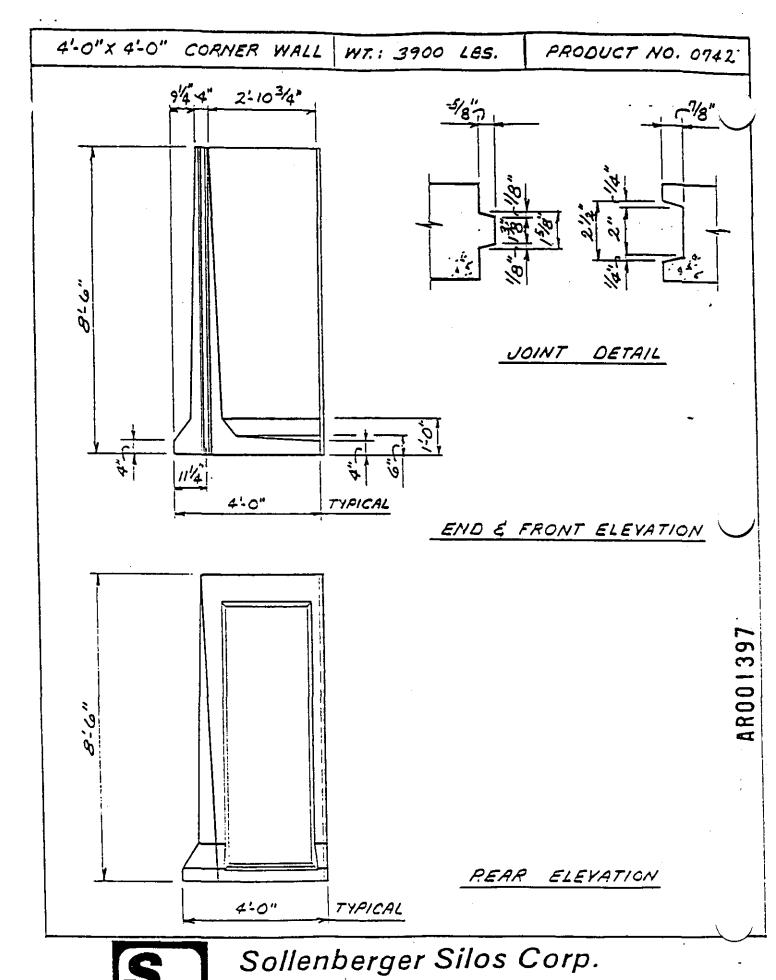
ISSUE	DATE	ISSUE	DATE	SILO MAT			
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FUR APPROVAL.	8/11/90			TUB MUT			
FER REVISE UCTION	7			" SM3			



NOTE: THE TOLERANCE FOR THE D8.8 WIRES SHALL BE NO MORE THAN $^{1}\!\!4''$ FROM THE LOCATIONS SHOWN ABOVE.

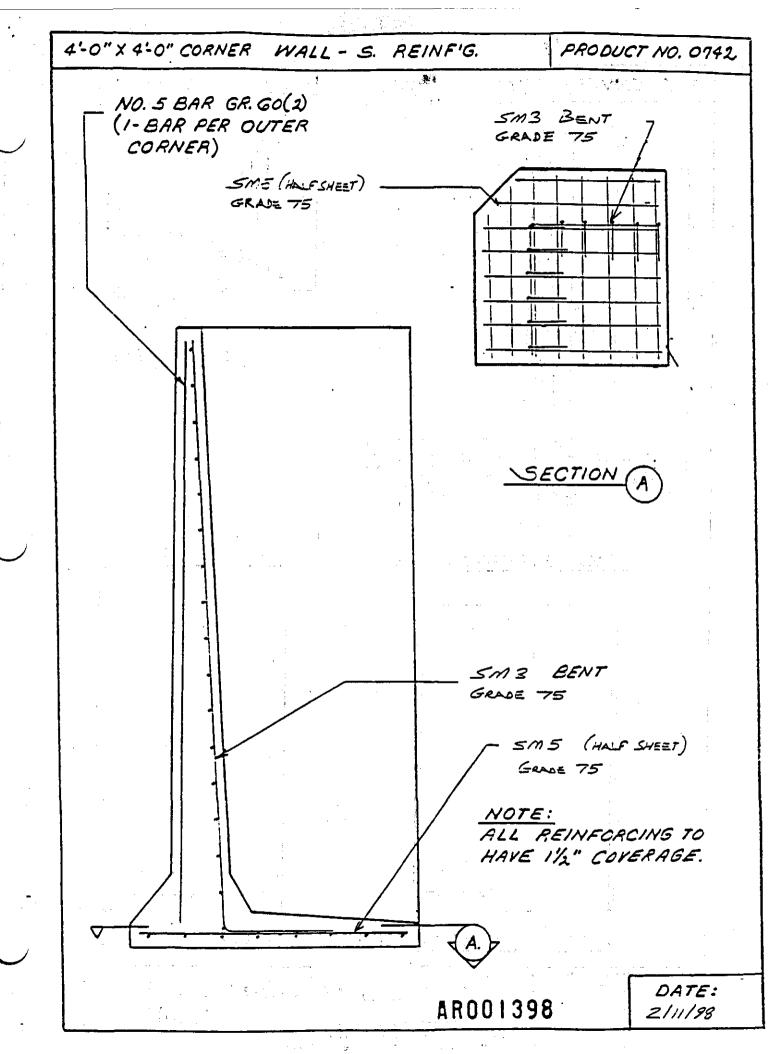
YIELD STRENGTH = 75 KSI

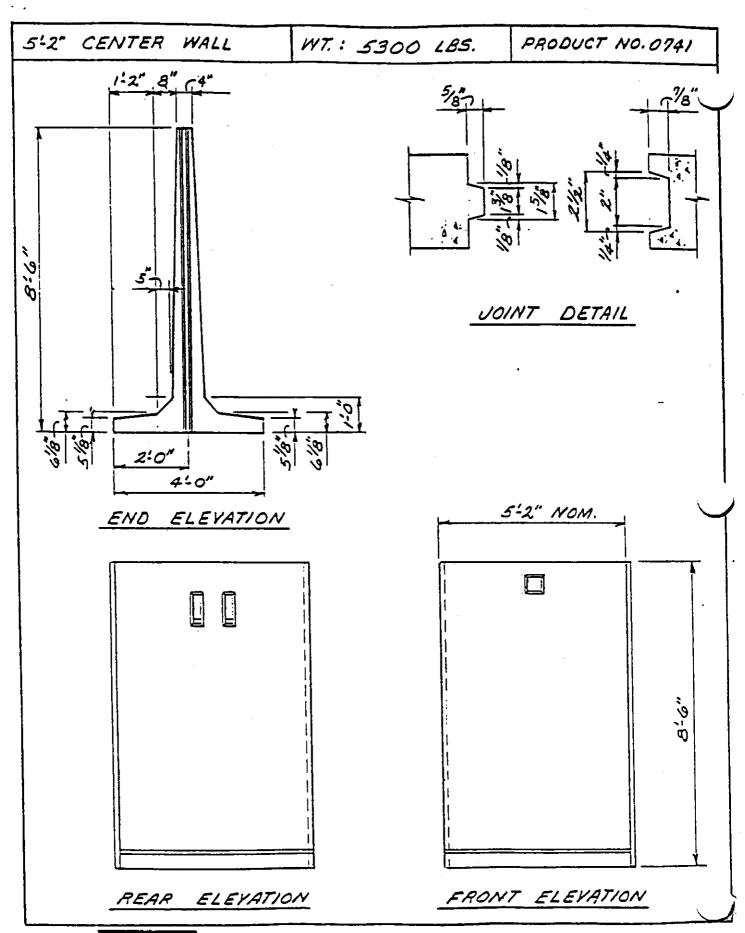
ISSUE	DATE	ISSUE	DATE	SILO MAT			
FOR ORDERING FOR FORM MUTLIDING		FOR REVISED PRODUCTION A		PLANT HARDWARE			
FOR APPROVAL				JDD NG. SIIT. NO.			
FOR PRODUCTION	E/11/98			SM5			
FOR REVISED PRODUCTION				3113			



A Nitterhause Campany
Sax N. Chambersburg, PA 17201
A Producter of Quality Concrete Products Since 1923

DATE :







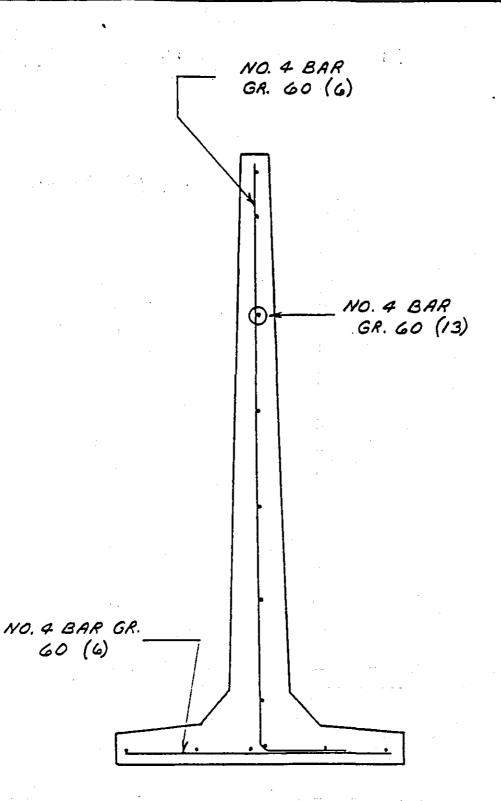
Sollenberger Silos Corp. A Ninerhouse Campany AR001399

A Nitterhouse Campany

Box N, Chambersburg, PA 17201

A Producer of Quality Concrete Products Since 1923

DATE:

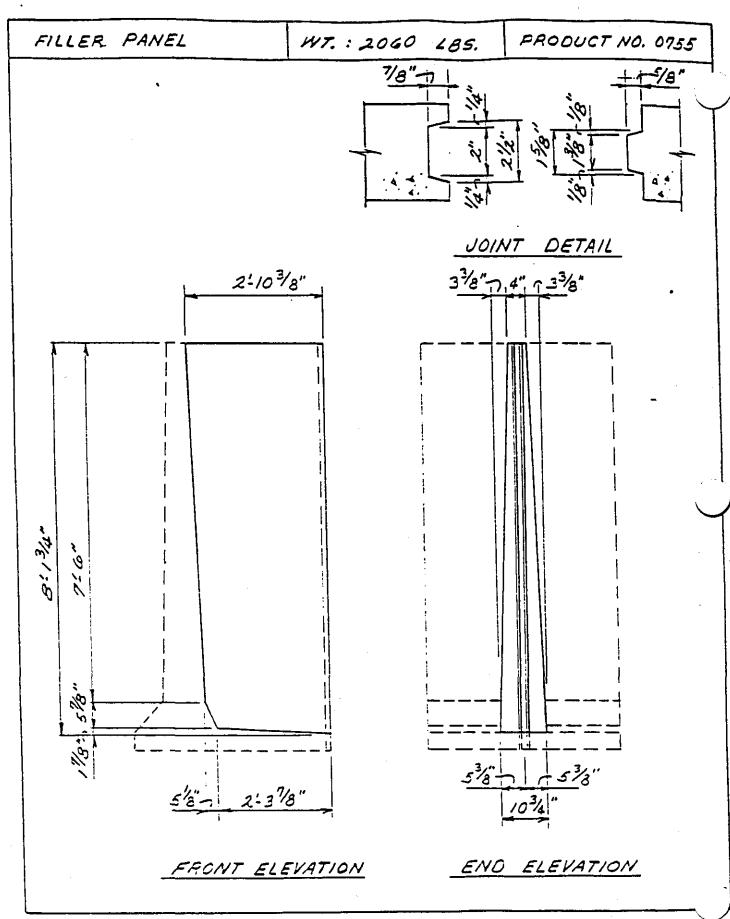


ALL REINFORCING TO HAVE 1/2" COYERAGE.

60 (6)

AR001400

DATE: 3-92



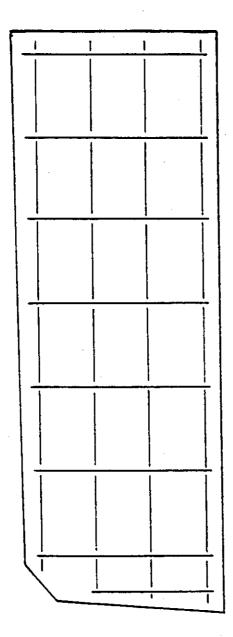


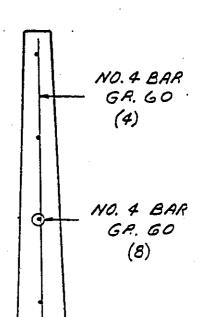
Sollenberger Silos Corp.

A Nitterhause Company
Box N. Chambersburg, PA 17201
A Producer of Quality Concrete Products Since 1923

AR001401

DATE:





NOTE:
ALL REINFORCING TO
HAVE 1/2" COVERAGE.

AR001402

DATE: 3-92

VENDOR INFORMATION

Soil Stockpile Cover



TOLL FREE NO. 800/231-6074

- ♦ P.O. Box 750250 ♦ Houston, Texas 77275-0250 ♦ Fax: 713/947-2053
- ♦ Telex: 077-5154 ♦ In Texas or outside the continental U.S.A., call collect 713 / 943-0070

Analysis of TX-1200 Black after Long-Term Exposure

Scope:

A sample of TX-1200 Black was obtained from a company that had used this material in a landfill application near Seattle, Washington. The installation date for the material was November, 1986. The sample was taken and submitted to us for testing in late May, 1989.

Method:

As sample size was limited, we were able to perform Tensile & Elongation, PPT Tear, Cold Crack and Thickness testing only. See the table below for the comparitive data and results.

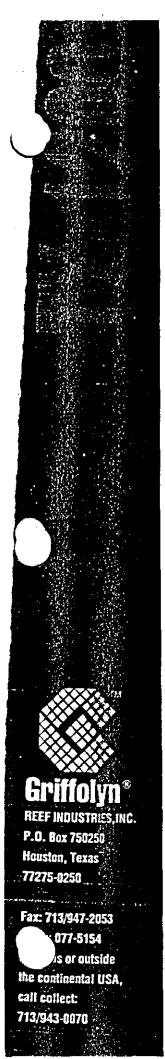
Data:

Property		λSTM Method	Units	Un - Exposed	Exposed	% Change
Thickness		D-2103	mils	4.5	5.0	
3" Tensile	- MD	D- 882	lbs	63.0	67.0	
			psi	4667	4467	-4.3
	- TD		Ìbs		70.0	
			psi		4667	
3" Elongation	- MD	D- 882	_ \	620	550	-11.3
•	- TD				150	
PPT Tear	- MD	D-2582	lbs	13.5	16.2	20.0
	- TD				15.4	
Cold Crack		D-1709	deg F	< −10	< -10	

Results: The sample was cleaned with water and examined visually for delamination, chalking, crazing etc. There were no visible signs of degradation. The test results as compared to unexposed product show no deleterious effects resulting from exposure to the elements for a period in excess of 2.5 years. The increase in PPT most likley is due to heat and age curing of the laminating adhesive. Some decline in the physical properties over a period of time is to be expected; however, tensile values are completely acceptable and the fall off in elongation may be due to the effects of the curing of the adhesive (ie. a more tightly locked matrix would give less leeway for freedom of motion of the film layers). This material has performed very well and, based on the results, should continue to give good service for quite a while.

D.G. Dewsnap





TECHNICAL INFORMATION ON GRIFFOLYN® TX-1200

Griffolyn TX-1200 is a 3-ply, Linear Low
 Density polyethylene copolymer and nylon yarn laminate. Reinforcement consists of a non-woven grid of high strength cord which provides a uniform loading

resistance of no less than 720 pounds per yard in all directions. Nylon reinforcing is in a diamond pattern with no fewer than 48 yarns per square foot. Yarn is suspended in a permanently flexible adhesive media to allow fiber slippage.

CUSTOMER BENEFITS

Engineered for performance, Griffolyn®means strength, quality and integrity.

- 3-layer reinforced with heavy duty nylon cord to resist punctures and tears
- UV stabilized, cold-crack resistant and waterproof to withstand extended exposure to adverse weather
- Chemical resistance and low permeability to provide maximum, continuous protection
- Flexible and lightweight for ease-in-handling
- Reusable and long life expectancy

SUGGESTED APPLICATIONS

Custom fabricated to exact specifications and configurations.

- Outdoor storage, pallet, cable reel and drum covers
- Laydown covers and cleanroom enclosures
- Temporary walls, plant dividers and containment tents
- Vapor barriers, building enclosures, dust partitions and concrete curing covers
- Agriculture storage systems, hay covers and windbreaks
- Shipping container covers and liners
- Erosion control and slope protection covers
- Field and equipment covers

CALL TOLL FREE

1-800-231-6074 AR001405

COLORS

Griffolyn®TX-1200 applications are endless. Available colors include clear, white, black and blue.

SIZE

Stock roll sizes from
4' x 100' to 40' x
100' in increments of
4' widths. Custom
sizes up to 200' x
200'. Stock length
width tolerances
are +1% (minimum
2") on stock items.
Custom fabrication to
exact specifications
and configurations.

OUTDOOR EXPOSURE

Average 20 to 48 months life expectancy under normal continuous exposure, dependent on color.

USABLE TMPERATURE ...NGE

Minimum -40° F to maximum +170° F

GRIFFOLYN® TX-1200 SALES SPECIFICATIONS

PHYSICAL F	ROPERTIES A	ND TYPIC	AL VALUES
PROPERD	(CODERNAGE)	VANUE - S	==UNITS
Weighter Noongen			poundaper HDOOsof(k
3º ensie mis	: chaldhinea		Jounds
		3000	i pr
3' elongation md	ASTM D 882	650	
Pakenetengh	'ASTM'D 2582	78	govids
3X8 tongue tear	ASTM D-2261	# 9 0 See -	pounds a
Cold crack	ASTM D-1709 mod	Tisto di A	
Drop dart	ASTM 0-1709	900	grams
Hot air shrink 170° F	ASTM D-1204	22.0°	% total area



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VENDOR INFORMATION

Concrete Joint Sealants Concrete Surface Sealants



Sikaflex® 11 FC

One part advanced polyurethane, elastomeric sealantladhesive

DESCRIPTION

Sikaflex 11 FC is a one-component, gun-grade, adhesive and sealing compound of permanent elasticity. This dual-purpose material is based on a special moisture-cured polyurethane with an accelerated curing time.

WHERE TO USE

As an elastic adhesive for:

- ▲ Cover plates, gaskets and coverings.
- A Acoustic ceiling tiles.
- A Floor moldings and door sills.
- A Light weight construction materials.
- Wood, metal, or plastic window and door frames.
- ▲ Roof tiles.

As an elastic joint sealer for:

- Air ducts and high vacuum systems.
- ▲ Containers, tanks, and silos.
- ▲ Gaskets in openings in walls or floors for ducts, pilling, etc.
- Reservoirs or water retaining structures.
- ▲ Aluminum fabrication.
- ▲ Bolted lap joints.

ADVANTAGES

- ▲ Excellent adhesion on all cementbased materials, brick, ceramics, glass, metals, wood, epoxy, polyester, acrylic resin, and plastics.
- ▲ Fast cure rate.
- ▲ Good weathering and water resistance.
- ▲ Non-corrosive.
- Can be painted over with water, oil, and rubber-based paints. (Preliminary tests recommended).
- ▲ High durability.

COVERAGE

10.3 ft. oz. cartridge seals 12.4 lineal ft. of $\frac{1}{2}$ x $\frac{1}{2}$ in. joint.

PACKAGING

Disposable 10.3 fl. oz., moisture-proof composite cartridges, 12/case.

	FOR SIKAFLEX 11 FC ring conditions @ 73F and 50% R.H.)
SHELF LIFE	9 months in unopened container.
STORAGE CONDITIONS	Store at 40-95F (4-35C). Condition material to 65-75F before using.
COLOR	White
APPLICATION TEMPERATURE	40 to 100F. Sealant should be installed when joint is at midrange of its anticipated movement.
SERVICE RANGE	-40 to 170 F
CURING RATE	Tack-free Time (TT-S-00230C) 1 to 2 hours depending on climate. Final Cure 5 to 8 days
RECOVERY	ASTM C719 >90%
SHORE A HARDNE	ESS (ASTM D-2240) 40-45
TENSILE PROPER Tensile Stress Elongation at Bre	TIES (ASTM D-412) 225 psi eak 600%
13 F/50% RH 1	ENGTH (ASTM D-1002) modified, glass substrate 165 psi
WEATHERING RESISTANCE	Excellent
CHEMICAL RESISTANCE	Good resistance to water, weak acids, weak alkalis, sewerage, mineral oils, vegetable oils, fats, fuels,. (Not resistant to organic solvents, paint thinner, strong acids, strong alkalis). Consul

Technical Service for specific data.

HOW TO USE

SURFACE PREPARATION

Clean all surfaces. Joint walls must be sound, clean, dry, frost-free, and free of oil and grease. Curing compound residues and any other foreign matter must be thoroughly removed.

PRIMING

Priming is not usually necessary for anodized aluminum, steel, non-absorbent materials such as glass, ceramics, stoneware and tiles. Most substrates only require priming if testing indicates a need or where sealant will be subjected to water immersion after cure. Consult Technical Service for additional information on priming.

APPLICATION

Recommended application temperatures: 40-100F. For cold weather application, condition material to 65-75F before using.

Place nozzle of gun into bottom of the joint and fill entire joint. Keep the nozzle in the sealant; continue on with a steady flow of sealant preceding the nozzle to avoid air entrapment. Avoid overlapping of sealant to eliminate entrapment of air. Tool as required. Joint dimension should allow for 1/4 inch minimum and 1/2 inch maximum thickness for sealant. Proper design is 2:1 width to depth ratio.

STORAGE

Store in dry warehouse conditions between 40F and 80F. Shelf life under these conditions is 9 months.



Sikaflex® Sealant/AdhesivePrimers

260/205, 429/202, 449/203 and 35

DESCRIPTION

Sikaflex primers are special materials formulated to improve the bond of Sikaflex urethane sealants when applied to specific substrates.

SIKAFLEX PRIMER 2601205

Sikaflex Primer 260/205 promotes adhesion of urethane sealants to various metallic, non-metallic, and plastic substrates.

SIKAFLEX PRIMER 429/202

Sikaflex Primer 429/202 promotes adhesion to clean, sound, and dry concrete, masonry, and wood — including teak and mahogany.

SIKAFLEX PRIMER 449/203

Sikaflex Primer 449/203 is used to promote adhesion to pvc, solvent-based enamel, PPG's fluorocarbon Duranar-finish, and certain plastics such as ABS and Plexiglas.

SIKAPLEX PRIMER 35

Sikaflex Primer 35 promotes adhesion to clean, sound and dry concrete and masonry.

WHERE TO USE

Most substrates require a primer only if testing shows need for it or where the sealant will be underwater after cure. Certain substrates do require a primer under all conditions.

ADVANTAGES

- ${\color{red}\blacktriangle}$ Single-component, ready to use.
- ▲ Easily applied by brush, dauber, or spray.

TYPICAL DATA FOR SIKAFLEX PRIMERS (Material and curing conditions 73F and 50% R.H.)

COLOR	Clear		<u>.</u>
SHELF LIFE	6 months in origin	nal, unopened container	rs.

COVERAGE

Following are average coverages, depending on porosity of substrate:

Sikafiex Primer	Coverage per pint Lin. ft. ½-x½-in.joint
260/205	300-500
429/202	300
449/203	300-500
35	300

PACKAGING

Sikaflex 260/205 and 449/203 primers are available in pints, 6/carton.

Sikaflex 429/202 primer is available in pints, 6/carton; and gallons, 4/carton. Sikaflex 35 Primer is available in 6 oz. containers, 6/carton.

HOW TO USE

SURFACE PREPARATION

The key to good bondability with Sikaftex sealants/primers is surface preparation. Specifically, all surfaces must be dry and free of dirt, grease, mold release agents, loose mortar, laitance, and any foreign matter. If the joint contains old sealant, it and all extraneous material must be removed and the substrate cleaned by mechanical means. Apply primers at substrate temperatures of 40 F and rising. Surface must be frost free.

APPLICATION

Shake or stir primer well before using. Apply to dry, clean, oil free surface with a brush, dauber or spray.

Sikaflex Primer	Dry time before installing sealant		
260/205	>1 hr. <8 hrs.*		
429/202	>1 hr. <8 hrs.*		
449/203	>30 min. <8 hrs.*		
35	>1 hr. <5 hrs.**		

- If sealant cannot be installed within 8 hours of priming, reprime.
- "If sealant cannot be installed within 5 hours of priming, reprime.

LIMITATIONS

- ▲ Primer should not be used if it starts to gel in container.
- Protect Sikaflex primers from moisture. Once container has been opened, use contents immediately.
- ▲ Do not attempt to use partial containers.
- Do not reseal or reuse. Resealing may cause moisture contamination and gelling.

CAUTION

SIKAFLEX PRIMER 260/205

Flammable; Irritant; Polson - Contains methanol. May cause skin/eye/respiratory irritation. Avoid contact. Methanol is a poison and may cause blindness if ingested. Use only with adequate ventilation. Use of safety goggles and chemical resistant gloves is recommended. In case of exceedance of PELs, use an appropriate, properly fitted NIOSH/MSHA approved respirator. Remove contaminated clothing. Keep away from heat, sparks, and open

SIKAFLEX PRIMER 429/202

Flammable; Irritant; Sensitizer - Contains aromatic polyisocyanate, xylene, PGMEA, TDI. May cause skin/eye/respiratory irritation. May cause skin and/or respiratory sensitization after prolonged or repeated contact. Avoid contact. May cause headaches, dizziness or other CNS effects. TDI is a suspect carcinogen (IARC, NTP). Use only with adequate ventilation. Use of safety goggles and chemical resistant gloves is recommended. In case of exceedance of PELs, use an appropriate, property fitted NIOSH/MSHA approved respirator. Remove contaminated dothing. Keep away from heat, sparks, and open flames.

SIKAFLEX PRIMER 449/203

Flammable: Irritant; Sensitizer-Contains xylene, butyl acetate, methylethyl ketone, toluene. May cause skin/eye/respiratory irritation. May cause skin and/or respiratory sensitization after prolonged or repeated contact. Avoid contact. May cause headaches, dizziness or other CNS effects. Use only with adequate ventilation. Use of safety goggles and chemical resistant gloves is recommended. In case of exceedance of PELs, use an appropriate, properly fitted NIOSH/MSHA approved respirator. Remove contaminated clothing. Keep away from heat, sparks, and open flames.

SIKAFLEX PRIMER 35

Flammable; Irritant; Sensitizer; Polson-Contains xylene, methanol, ethyl acetate, epoxy resin, diacetone alcohol. May cause skin/eye/respiratory imitation. May cause skin and/or respiratory sensitization after prolonged or repeated contact. Avoid contact. May cause headaches, dizziness or other CNS effects. Methanol is a poison and may cause blindness if ingested. Use only with adequate ventilation. Use of safety goggles and chemical resistant gloves is recommended. In case of exceedance of PELs, use an appropriate, properly fitted NIOSH/MSHA approved respirator. Remove contaminated clothing. Keep away from heat, sparks, and open flames.

FIRST AID

In case of skin contact, wash immediately and thoroughly with soap and water. If symptoms persist, consult physician. For eye contact, flush immediately with plenty of water for at least 15 minutes; contact a physician. For respiratory problems, remove person to fresh air, if symptoms persist, consult physician. In case of ingestion, consult a physician immediately-methanol is a poison. Remove contaminated clothing.

CLEAN UP

In case of spill or leaks, wear suitable protective equipment, contain spill, collect with absorbent material, and transfer to suitable container. Ventilate area. Avoid contact. Dispose of in accordance with current, applicable, local, state and federal regulations.

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Sika Mexicana S.A. de C.V. Carretera Libre Celaya Km. 8.5 Corregidore, Queretaro C.P. 76920 A.P. 136 Phone: 52 42 25 0122 Fax: 52 42 25 0537



Sikafloor® 450/455 Traffic System

Elastomeric, crack-bridging, waterproofing, traffic system

DESCRIPTION

Sikafloor 450/455 is a single component, moisture cured elastomeric polyurethane coating system designed for use as water-proofing membranes for pedestrian and vehicular traffic bearing surfaces.

System Components:

Sikafloor 152 - two component epoxy primer Sikafloor 450 - one component polyurethane coating

Sikafloor 451 Thixo - one component polyurethane coating, slope grade

Sikafloor 454 Booster - accelerator for extreme curing conditions

Sikafloor 455 - one component polyurethane top coating

WHERE TO USE

Sikafloor 450/455 elastomeric, waterproofing membrane system is designed for use on concrete and cementitious surfaces exposed to vehicular and pedestrian traffic or where high thermal movement is anticipated.

- ▲ Multi-story parking garages
- ▲ Traffic ramps
- ▲ Garage floors
- ▲ Foot bridges
- ▲ Elevated balconies
- ▲ Stadiums and arenas
- ▲ Rooftop recreational areas

ADVANTAGES

- ▲ Excellent crack-bridging properties and flexibility even at low temperatures.
- ▲ Good resistance to mechanical damage.
- ▲ Outstanding resistance to abrasion and wear.
- ▲ Impervious to water and de-icing salts.

PACKAGING

Sikafloor 152: 3 gal. units

Sikafloor 450: 5 gal. pails, 55 gal. drums

Sikafloor 451 Thixo: 5 gal. pails

Sikafloor 454 Booster:

Sikafloor 455: 5 gal. pails, 55 gal. drums

COLORS

Sikafloor 450/451 Thixo: Gray

Sikafloor 455: Light Gray, Dark Gray, Tan

HOW TO USE

Surface must be clean, dry and sound with an open texture. Remove dust, laitance, grease, curing compounds, bond inhibiting impregnations, waxes, and any other contaminants.

Preparation work: All projections, rough spots, etc. should be dressed off to achieve a level surface prior to the application. Concrete - Should be cleaned and pre-

Uncured Material:	Sikafloor 450	Sikafioor 451 Thixo	Sikafloor 455
SHELF LIFE	1 year in original, unopened containers		
STORAGE CONDITIONS	Store dry at 45-90F (7-32C). Condition materials to 60-85F (18-29C) before using.		
VISCOSITY (Approximately)	5000 cps	Thixotropic Liquid	4000 cps
Cured Film: 7 day cure at 73F/50% RH			
TENSILE STRENGTH (ASTM D412)	650 psi (4.4 MPa)	650 psi (4.4 MPa)	2100 psi (14.4 MPa)
ELONGATION AT BREAK (ASTM D412)	400%	350%	225%
TEAR RESISTANCE (ASTM D1004)	150 Pli	150 Pli	350 Pli
HARDNESS SHORE A (ASTM D2240)	40	40	85
ABRASION RESISTANCE (ASTM D4060)	**		25 mg

pared to achieve a laitance and contaminant free, open textured surface by blast cleaning or equivalent mechanical means. Sikagard 75 EpoCem applied at 80 mils (2 mm) can be used in areas of high vapor drive, over damp or green concrete to reduce potential of osmotic blistering. Finished substrate profile should be similar to ICRI recommendations SP-3 to SP-5.

Steel - Should be cleaned and prepared thoroughly by blast cleaning.

PRIMING

Prime surface with Sikafloor 152. Primer must be worked well into the substrate to ensure adequate penetration and sealing of the surface to avoid pin-holes which could lead to blow-holes or delaminations of subsequent coats through osmosis (See Technical Data Sheet for Sikafloor 152 for more detailed information).

DETAILING

Detail only non-structural cracks. Cracks up to 1/16 inch: Apply a coat of Sikafloor 152, 4 inch wide centered over crack. Allow to dry to tack free and apply a detail coat of Sikafloor 450 (Sikafloor 451 Thixo in sloped areas) at 40 wet mils, 4 inch wide, centered over crack. Allow detail coat to dry to tack free before overcoating. Cracks over 1/16 inch up to 1/2 inch: Route and seal crack with Sikaflex 2c, allow to cure. Apply a prime coat of Sikafloor 152, 2 inch on each side of crack (do not apply over sealant). Allow to dry to tack free and apply a detail coat of Sikafloor 450 (Sikafloor 451 Thixo in sloped areas) at 40 wet mils, 4 inch wide, centered over crack. Allow detail

coat to dry to tack free before overcoating. Cracks over 1/2 inch: Should be treated as moving joints and brought up through the Sikafloor Traffic System and sealed with Sikaflex 2c. Control Joints: Seat control joints with Sikaflex 2c. Detail sealed joints according to recommendation for cracks over 1/16 inch up to 1/2 inch.

BASE COAT

Thoroughly mix Sikafloor 450/Sikafloor 451 Thixo prior to use. Apply a base coat at 32 wet mils (25 dry mils) using a notched trowel. Extend base coat over cracks and control joints which have been treated with detail coats. Apply base coat the same day as prime coat has been applied.

WEARING COAT

Thoroughly mix Sikafloor 455 prior to use. Apply at the recommended thickness (see system build-ups) and immediately broadcast aggregate (properly graded, 6.5 + Moh's scale) evenly distributed at the appropriate rate. Allow 48 hours @ 72F, 50% R.H. Cure after 455 is tack-free before opening to traffic.

LIMITATIONS

- ▲ To avoid dew point conditions, control ambient temperature, relative humidity and substrate temperature during application.
- Maximum moisture content of substrate: 4% by weight.
- Minimum ambient and substrate temperatures during application and curing of material is 45F (7C).
- Do not store materials outdoors exposed to

sunlight for prolonged periods.

- ▲ Do not thin with solvents.
- ▲ Use oven dried aggregates only.
- ▲ Minimum age of concrete must be 21-28 days, depending upon curing and drying conditions, (or apply Sikagard 75 EpoCem).
- ▲ Porous substrates must be tested for moisture-vapor transmission prior to application.
- A All superficial repairs required to achieve a level surface in the application area must be performed prior to application. (All surface irregularities may reflect through the cured system).
- ▲ Do not apply during outgassing of moisture.
- ▲ Opening area prior to final cure may result in loss of aggregate, or permanent staining and subsequent premature failure.

CAUTION

FLAMMABLE: IRRITANT Sikafloor 450/451:

Sensitizer; Contains polyisocyanate prepolymer, xylene. May cause skir/eye/ respiratory irritation. May cause skin and/or respiratory sensitization after prolonged or repeated contact. Avoid skin contact. Overexposure to xylene may cause headaches, dizziness, or other CNS effects. Use only with adequate ventilation. Use of safety goggles and chemical resistant gloves is recommended. If PELs are exceeded, use an appropriate, properly fitted NIOSH/MSHA approved respirator. Remove contaminated clothina.

Sikafloor 455:

Sensitizer; Combustible Liquid -Contains xylenes, isocyanate prepolymer. Can cause skin and/or respiratory sensitization after prolonged or repeated exposure. Skin, eye, respiratory irritant. Avoid skin contact. Use only with adequate ventilation. Use of safety goggles and chemical resistant gloves is recommended. In case of exceedance of PELs, use an appropriate, properly fitted NIOSH/MSHA approved respirator. Remove contaminated clothing. Keep away from sparks, open flames and high heat.

FIRST AID:

in case of skin contact, wash immediately and thoroughly with soap and water. symptoms persist, consult physician. For eye contact, flush immediately with plenty of water for at least 15 minutes, contact a physician. For respiratory problems, remove person to fresh air; if symptoms persist, contact a physician. In case of ingestion, dilute with water and consult physician. Remove contaminated clothing.

CLEAN UP:

In case of spills or leaks, wear suitable protective equipment, contain spill, collect with absorbent material and transfer to suitable container. Ventilate area. Avoid contact. Dispose of in accordance with current, applicable, local, state, and federal regulations.

SYSTEM BUILD UP:

	Pedestrian Traffic	Medium Trafflic	Heavy Traffic	Extreme Traffic
Primer Sikafloor 152	150-300 ft ³ /gal. (depending on substrate condition)	150-300 ft ² /gal (depending on substrate condition)	150-300 ft ² /gal. (depending on substrate condition)	150-300 ft2/gal. (depending on substrate condition)
Detail Coat Sikafloor 450/ Sikafloor 451	25 mils wet/20 mils dry	38 mils wet/30 mils dry	38 mils wet/30 mils dry	38 mile wet/30 mile dry
Sase Coat Sikafloor 450/ -kafloor 451	32 mils wet/25 mils dry	32 mils wet/25 mils dry	32 mils wet/25 mils dry	32 mile wet/25 mile dry
Intermediate Coat I Sikafloor 455		15 mils wet/10 mils dry 0.8 - 1.0 lbs./ft² (16-30 mesh) or to rejection	23 mils wet/15 mils dry 0.8 - 1.0 lbs./ft² (16-30 mesh) or to rejection	23 mils wet/15 mils dry 0.8 - 1.0 tbs:/ft2 (16-30 mesh) or to rejection
Intermediate Coat II Sikafloor 455		·································	·	23 mils wet/15 mils dry 0.8 - 1.0 lbs./ft2 (16-30 mesh or to rejection
Top Cost	15 mils wel/10 mils dry 0.10 - 0.20 (bs./ft2 (20-40 mesh)	15 mils wet/10 mils dry lock-coat	23 mils wet/15 mils dry lock-coat	15 mils wel/10 mils dry lock-coat
Totals	35 mils dry	45 mils dry	55 mils dry	65 mils dry

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Sikafloor® 152 Primer

Low-viscosity, VOC-compliant, epoxy resin primer

DESCRIPTION

Sikafloor 152 Primer is a 2-component, VOC-compliant, moisture insensitive, low-viscosity epoxy resin primer.

WHERE TO USE

Sikafloor 152 Primer is used on concrete and mortar substrates prior to the application of Sikafloor 450/455 traffic system.

ADVANTAGES

- ▲ Improves the bond of Sikafloor 450/455 traffic system.
- Deep penetration; seals pores and micro cracks.
- Provides a uniform surface for the subsequently applied membrane.
- ▲ VOC-compliant system.

COVERAGEIYIELDS:

Approximately 150-300 sq.ft./gal. (3.7 - 7.4 sq. meters/liter), depending on substrate profile and porosity.

PACKAGING

3 gal. unit (11.4 liters) consists of 2 gal. (7.6 liters) Component A and 1 gal. (3.8 liters) Component B.

HOW TO USE

SURFACE PREPARATION

Surface must be clean, dry and sound with an open texture. Remove dust, laitance, grease, curing compounds, bond inhibiting impregnations, waxes, and any other contaminants.

Preparation work: All projections, rough spots, etc. should be repaired to achieve a level surface prior to the application.

Concrete - Should be prepared to achieve an open textured surface by blastcleaning or equivalent mechanical means. Sikagard 75 EpoCem applied at 80 mils (2 mm) can be used in areas of high vapor drive over damp or green concrete to reduce potential of osmotic blistering. Finished substrate profile should be similar to tCRI recommendations SP-3 to SP-5.

Corrosion inhibiting impregnation pretreatment (optional): FerroGard 903 corrosion inhibitor may be applied prior to the application of Sikafloor Traffic System to address latent damage caused by ongoing corrosion activity at the reinforcing steel level. (See FerroGard 903 Technical Data Sheet for preparation of treated substrate prior to the application of Sikafloor Traffic System.)

TYPICAL DATA FO (Material and curin			50% R.H.)	
SHELF LIFE	18 months in o	riginal, unopened	container.	
STORAGE CONDITIONS	Store dry at 40 29C) before u		ondition material (to 65-85F (18-
COLOR	Clear	1		
FLASHPOINT	Component A Component B	85F (29C) 83F (27C)		
MIXING RATIO	Component A:	Component B = 2	:1 by volume	
VISCOSITY	Approximately	1000 cps. (Compo	onents A + B mixe	d)
TACK-FREE TIME	4 mils	50F (10C) *5 hrs.	73F (23C) 4 hrs.	95F (35C) 2 hrs.

Material cured and tested at the temperatures indicated * 30 minutes induction time is required after mixing.

MIXING

Mix entire unit (2 gal. Component A and 1 gal. Component B). If proportioning of the components is necessary, premix each component first, then proportion 2 parts of Component A and 1 part of Component B by volume into a clean pail. Mix thoroughly for 3 minutes with Sika paddle and low speed drill until uniformly blended. Pause during the mixing cycle to scrape the sides of the pail.

APPLICATION

Spread neat Sikafloor 152 Primer over prepared substrate working the material thoroughly into the substrate with a high quality roller or brush to ensure penetration. If using a squeegee, the spread material should be subsequently back-rolled to assure coverage and penetration, and to avoid pinholes. When primer is tack-free, apply base coat Sikafloor 450. Where the maximum overcoat time is to be exceeded, broadcast the wet primer with clean, dry silica sand and when dry, remove any excess sand. Where the overcoat time is exceeded without broadcasting, the primed surface has to be solvent wiped and another coat of primer applied.

LIMITATIONS

- ▲ Minimum age of concrete is 21-28 days, depending on curing and drying conditions. For overcoating "green" (young) concrete, use Sikagard 75 EpoCem, provided the required concrete strengths are achieved.
- Minimum strength requirements for substrate:
 - Compressive Strength 3,000 psi (20.7 N/mm²) Pull-off Strength 150 psi (1.0 N/mm²)
- ▲ Minimum substrate and ambient temperatures 45F (7C).
- Avoid dew point conditions. Check substrate, ambient temperatures and relative humidity. Apply only when minimum 5F (3C) above dew point temperature.
- Do not apply over wet, glistening surfaces.
- Porous substrates must be tested for moisture-vapor transmission prior to the application.
- Do not store materials outdoors exposed to sunlight for prolonged periods.
- Induction time is required when temperatures are below 60F (15C) to reduce tack free time.

CAUTION

COMPONENT A

Flammable: Irritant; Sensitizer; CNS

Keep away from sources of ignition. Skin and eve irritant. High concentrations of vapor may cause respiratory irritation. May cause skin sensitization after prolonged or repeated contact. Avoid skin contact. Use only with adequate ventilation. Use of safety goggles and chemical resistant gloves is recommended. Remove contaminated clothing.

COMPONENT B

Flammable; Irritant; Sensitizer;

Corrosive

Keep away from sources of ignition. Skin and eye irritant. High concentrations of vapor may cause respiratory irritation. May cause skin sensitization after prolonged or repeated contact. Avoid skin contact. Use only with adequate ventilation. Use of safety goggles and chemical resistant gloves is recommended. Remove contaminated clothing.

FIRST AID:

In case of skin contact, wash immediately and thoroughly with soap and water. If symptoms persist, consult physician. For eye contact, flush immediately with plenty of water for at least 15 minutes, contact a physician. For respiratory problems, remove person to fresh air; if symptoms persist, contact a physician. Do not induce vomiting. In case of ingestion, dilute with water and consult physician. Remove contaminated clothing.

CLEAN UP:

In case of spills or leaks, wear suitable protective equipment, contain spill, collect with absorbent material, and transfer to suitable container. Ventilate area. Avoid contact. Dispose of in accordance with current, applicable local, state, and federal regulations.

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House Page

Promets
Scal-Crete WPS
Seal-Krete Hi-Solids
Driveway Sealer
EZ-Coat Skid-Proof
Proformance Skid-Proof
Commercial Floor Sealer
Glow Paint
Graffiti Barrier
Silane Siloxane
Gator Hide

Proformance SP Seal-Krete WPS Prevent Chalking

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Finally, a way to protect costly concrete driveways and concrete floors



PRODUCT DESCRIPTION:

General Description

SEAL-KRETE Waterproofing Sealer (SKWPS) is a water-based, very low VOC (<8 grams/liter), strong-binding, clear acrylic, penetrating sealer/primer. It penetrates deeply into the pores of concrete, binding to the sand and cement particles, forming a tough, flexible and breathable film. It is formulated



for use on interior and exterior concrete, stucco, brick and masonry surfaces. It can also be used on wood, stone, porous roof tile, asphalt shingles, adobe, plaster, drywall, coral, limestone, grout, painted aluminum siding, vinyl siding and galvanized metal.

SKWPS is a 10% solids, low odor acrylic emulsion that applies milky white, which aids in uniform coverage, and dries in 1 to 2 hours to a tough, flexible, clear sealer. It is non-flammable, non-hazardous and non-staining. SKWPS is also available as a 25% Hi-Solids product for use on low density, porous vertical surfaces.

GENERAL USES

- SKWPS is a clear waterproofing sealer/primer/binder for concrete, brick, masonry and stucco surfaces. It may also be used on wood, stone, porous roof tile, asphalt shingles, adobe, plaster, drywall, coral, limestone, grout, painted aluminum siding, vinyl siding and galvanized metal.
- Can be used to help reduce efflorescence, erosion, chalking, spalling, cracking, rotting and other effects due to water penetration.
- Seals and binds chalky surfaces, improving the adhesion of a topcoat.
- Provides dustproofing on bare horizontal masonry surfaces (1 thin coat).
- Can be topcoated with acrylic latex paint, oil-based paint, elastomeric coatings, and mastics
- A primer/sealer for properly cleaned galvanized metal, it insures a better bond for the topcoat.
- Can be mixed with acrylic latex paint or stain to improve weatherability.
- Can be tinted with universal colorants. When tinted, it becomes a stain and seal.
- Can be applied to drywall prior to painting or wallpapering.
- Can be used on bare vertical masonry surfaces as a barrier against graffiti. (Contact Seal-Krete, Inc., Technical Department for details.)
- Can be applied to aged vinyl or painted aluminum siding to brighten and protect, or as a primer/sealer for painting.
- Can be used over weathered, oil-based paint to improve the adhesion of a latex topcoat.

ADVANTAGES

- Lasts up to 5 years (limited warranty available).
- Non-yellowing
- Environmentally safe Will not harm humans, plants or animals.
- Contains low Volatile Organic Compounds (VOCs).
- Water-based, Non-flammable, Low odor.
- Cleans up with water.
- Goes on milky white to aid in even application, but dries clear.
- Can be mixed with exterior latex or acrylic paints to improve weatherability and adhesion.
- Strong binding film properties
- Flexible with high tensile strength

- Breathable film
- Can be topcoated 1 to 2 hours after dry.
- Can be applied to concrete or stucco during the curing process it retards the evaporation of water, thus improving the strength of the cured concrete.
- Can be used on alkaline surfaces to lower the PH to an acceptable level before painting.
- It is a less expensive primer/sealer for concrete, reducing the use of more expensive topcoats.

TEST DATA

SKWPS meets or surpasses the following ASTM Standards or Federal Test Method Standards.

- ASTM E514-74 Water Permeance of Masonry (62 mph Wind Driven Rain Test)
- ASTM D1653 Moisture Vapor Transmission
- Federal Specification TT-P-0035 for Water Permeability (98 mph Wind Driven Test).
- SKWPS meets USDA criteria for a structural surface coating that may have incidental contact with food.

SURFACE PREPARATION

Surfaces must be clean and dry before applying SKWPS. Remove efflorescence, dirt, grease, oils, and other foreign matter from surfaces. Remove loose & peeling paint and excessive chalk. NOTE: When used as a waterproofer, surface must be bare. Scrape, scrub, sandblast, or pressure wash surfaces to clean as necessary. For dirt and mildew, use a recommended cleaner of 1 part household chlorine bleach to 3 parts water containing a non-ammoniated detergent. After cleaning, rinse surface thoroughly. Repair all cracks, crevices and surface breaks.

Cover surfaces not to be sealed (windows, doors, vehicles, etc.). Use caution if applying SKWPS with a sprayer. Overspray on windows and surfaces should be cleaned IMMEDIATELY with water. SKWPS does not stain or etch windows, but when dry, is difficult to remove. Removal of dried SKWPS from windows can be done with a safety razor blade.

EQUIPMENT AND APPLICATION

Apply SKWPS using a low pressure hand pump sprayer (garden sprayer), or airless sprayer. Back roll spray applications with a paint roller, to make wet coat uniform, and force the sealer into the pores. Flood coats for vertical surfaces must be applied liberally starting at the top, allowing SKWPS to run down the surface 6-8 inches. A minimum of 2 even, saturated coats are recommended. SKWPS can also be applied with a brush or roller. Additional coats may be required on very porous surfaces and can be applied 1 hour after the



previous coat is dry. (Typical drying time is 1 to 2 hours.) Clean up equipment with water IMMEDIATELY after use.

SUBSTRATES

Stucco – SKWPS can be applied to vertical stucco during the curing period, eliminating the 28 day wait necessary with most other coatings. SKWPS does not cause colored stucco to "bleed". A minimum of 2 flood coats are recommended. Allow SKWPS to dry at least 2 hours. Surface pH must be 7-9 before painting.

Poured Vertical Concrete – For tilt-ups and inplace, poured concrete, SKWPS can be applied as soon as forms are removed. Any release agent on the concrete must be removed. Apply a minimum of 2 flood coats. Surface pH must be 7-9 before painting.

Concrete Block (All types meeting ASTM C-90 Standards) – Apply a minimum of 2 flood coats of SKWPS to the surface. Back roll the second coat. The coverage per gallon for decorative block will be less because of the irregular surface area. Additional coats, or use of Seal-Krete Hi-Solids will be required on low density decorative block and other very porous substrates.

Concrete Slabs (Horizontal Patios, Floors, etc.)

New Concrete – When the finished concrete is still damp (green stage), apply 1 coat of SKWPS onto the surface. SKWPS will aid the curing process by retarding evaporation of water, thus strengthening the concrete.

Existing Concrete – Only 1 thin coat on bare horizontal surfaces is recommended for dustproofing.

NOTE: FOR DRIVEWAYS, SEAL-KRETE CONCRETE FLOOR/DRIVEWAY SEALER IS RECOMMENDED.

Vertical Brick – Apply a minimum of 2 flood coats. Back roll the second coat. SKWPS is excellent for use in restoration projects because it seals, binds and waterproofs old mortar and brick. Solvent-based sealers are unsatisfactory because they will cause further deterioration of old brick and mortar.

Vertical Wood – SKWPS can be applied to all vertical wood surface and wood products including pressure-treated wood, wafer board, pressed board and particle board. Before painting, knots should be treated with a stain-blocking primer. SKWPS does not prevent tannin stain on cedar and redwood. SKWPS protects wood, but allows the natural aging process (graying) to occur. Apply a minimum of 2 coats.

Wood Restoration – Before topcoating, SKWPS should be used on wood that has been stripped with an alkaline stripper to block any residual alkalinity. Residual alkalinity can cause paint to peel.

NOTE: Before applying SKWPS, follow stripper manufacturer's neutralization instructions. The surface pH should be 7-9 before painting.

Horizontal Wood – One or two thin coats of SKWPS can be used on bare, clean, dry (below 15% moisture content) wood. If thick or multiple coats are applied, dirt pick-up and after-tack can occur. SKWPS will not prevent tannin stain on cedar and redwood. SKWPS protects wood, but allows the natural aging process (graying) to occur.

Application as a Stain and Seal – when tinting, use latex stain or paint color charts for the desired color. Tint with universal colorants. For a transparent stain, it is recommended to use up to 4 ounces of colorant to each gallon of SKWPS. For a semi-transparent stain, mix 1 part desired color of exterior acrylic latex paint to 4 parts SKWPS. For a solid-hide stain, mix 3 parts desired color of exterior acrylic latex paint to 2 parts SKWPS. It is recommended that a quart or less of the product be mixed and applied to a test area to assure that the desired color is obtained. For all applications of SKWPS as a stain and seal, mix thoroughly before and during application.

Galvanized Metal – Before painting, clean galvanized metal surfaces with soap and water or a waterbased degreasing cleaner, then rinse thoroughly. Do not use organic solvents. SKWPS will not adhere to surfaces cleaned with organic solvents. Apply 2 even coats with no streaking or sagging.

Sheet Rock – Apply 2 even coats prior to wallpapering. Allow SKWPS to dry 24 hours before applying wallpaper or wallpaper adhesive.

Painted Surfaces — SKWPS will improve the adhesion of a topcoat on previously painted surfaces. For chalky surfaces, apply 1 coat, allow to dry and check for chalking. Two or more coats may be needed for heavily chalked surfaces.

Vinyl and Painted Aluminum Siding – Apply 1 or 2 coats to improve weatherability, appearance and/or increase the adhesion of a topcoat.

CAUTIONS/LIMITATIONS

- Use in a well-ventilated area.
- Do not allow SKWPS to freeze.
- Do not dilute SKWPS.
- Do not apply outside if rain is forecast within 8 hours of application.
- Do not apply if the air, substrate or product temperature is less than 50°F.
 Temperatures higher than 50°F must be obtained in the first 24 hours after application.
- Wait at least 14 days before applying over freshly painted surfaces.
- SKWPS may become slightly tacky from excessive heat when applied on existing concrete surfaces (driveways, garage floors, etc.) that are exposed to direct sunlight.
- SKWPS will not prevent tire marks from occurring.
- SKWPS is recommended for bare, horizontal masonry surfaces only as a sealer to control dust (1 thin coat).
- Do not apply below grade, or where hydrostatic pressure is expected.
- SKWPS does not protect against standing water. It is not meant to be used as an
 immersion product in pools or where continuously exposed to water (birdbaths, fish
 pons, etc.).
- Do not apply to glazed tile, glazed brick or brick pavers.
- · Keep out of reach of children.

MAINTENANCE

No maintenance required.

AVAILABILITY

SKWPS is available through dealers and distributors throughout the United States. SKWPS is available in 1 and 5 gallon plastic containers. Fifty-five gallon drums are available on special order.

DISPOSAL

Contains no chromium, lead, mercury or hazardous, poisonous materials. Place empty, open containers in normal refuse for disposal. Contact your local government Household Hazardous Waste Coordinator for information disposal of unused product.

WARRANTY

Limited 5 year warranty available. Seal-Krete, Inc., will warranty the quality and performance of this product on a per job basis up to 5 years. Write to Seal-Krete, Inc., for full details on available warranty. Guarantee of this product, when used according to the directions, is limited to refund of purchase price or replacement of product, if it is defective. Seal-Krete, Inc., shall not be liable for cost of labor or direct and/or incidental consequential damages. This guarantee gives you specific legal rights, and you may also have other rights which vary from state to state.

TECHNICAL SUPPORT

The enclosed technical information is as reliable as current technology allows. Additional information, including MSDS may be obtained by calling our Technical Service Department,

M-F, 8am-5pm EST at 863-967-1535 or 800-323-7357.

TECHNICAL DATA

Surface	Coverage (sq.ft/gallon)*
Stucco/Simulated Brick	150
Concrete Slab / Tilt up	175
Concrete Block**	80
Brick	125
Porous Roof Tile	175
Wood Shingles	125
Wood Siding / Fence	200
Adobe	100
Chalky Surfaces	300
Vinyl / Aluminum Siding	300

^{*}Actual coverage will vary depending on surface porosity. For second coat application, increase coverage by 50%.

**Profiled decorative block, because of its irregular surface, will lower coverage rates.

HEALTH DATA

Inhalation: Certain individuals may be sensitized and experience minor nausea or headaches. Remove the individual to fresh air. If symptoms persist, seek medical attention

Skin Contact: Prolonged skin contact may cause irritation. Remove contaminated clothing and wash affected skin with soap and water. Launder clothing before re-use. If symptoms persist, seek medical attention.

Eyes: Contact with eyes may cause irritation. Flush eyes with water for 15 minutes. If symptoms persist, seek medical attention.

Ingestion: May cause gastric distress, vomiting and diarrhea. Induce vomiting and seek immediate medical attention.

PROPERTIES SK WPS Liquid Properties

Solids	10%		
Solvent	Water		
Shelf Life	> 2 years		
Appearance	Milky White		
Odor	Low		
Recovery From Freeze/Thaw	.> 3 Freeze Thaw Cycles		
Application Temperature	50 - 150 degrees F		
VOC	< 8 grams/liter		

SK WPS Film Properties

Appearance	Clear, Slight Gloss		
Water Resistance	Excellent		
Tensile Strength	High		
Mechanical Stability	Excellent		
Light Stability	Excellent, 0.05% Fading in 312 hours Fadometer Test		

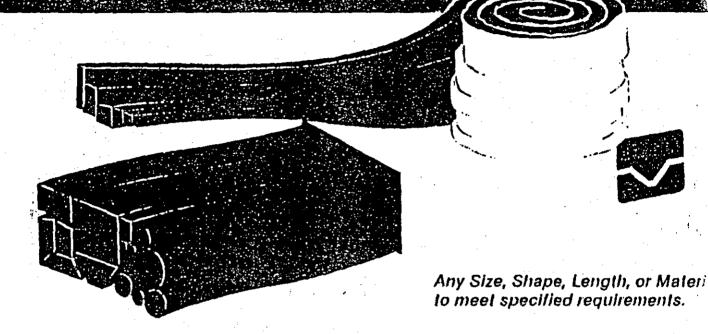
Click here for

on Seal-Krete Waterproofing Sealer



Updated 2/11/98

Bitumen Conseal cs:102:E



APPLICATION AND SEALING PROPERTIES

- · Provides permanently flexible watertight joints.
- Low to high temperature workability:
 - · D CS-102-B & CS-102-DO-B 45°F to 130°F.
- Rugged service temperature resistance of -30°F to + 200°F.
- Excellent chemical and mechanical adhesion to clean and dry surfaces.
- · Greater cohesive and adhesive strengths.
- Sealed joints will not shrink, harden or oxidize upon aging.
- · Available in numerous standard sizes:
 - ☐ Specific area cross sections designed for specific joint requirements.
 - ☐ Lengths 36" or 42" strips, plus rolls up
 - ☐ Custom cut lengths at minimum costs.
 - □ Lower sealing costs resulting from use of proper sizes.
- Controlled flow resistance for application ease.
- Primer is not usually required, however, if temperature is below 50°F, or installation is in a wet hole, or

- a dust condition exists, apply Concrete Sealants re ommended primer.
- Meets Federal Specification SS-S-00210 (210-A) at AASHTO M-198B.

FOR SELF-SEALING JOINTS IN:

- Concrete Manholes
- Concrete Pipes
- Vaults
- Utility Boxes
- Sewer Construction
- Septic Tanks
- Box Culverts
- Vertical Panel Structures

PROVEN SEALANTS FOR THE PRECAST CONCRETE INDUSTRY

SEALANT:

AR001421

Technical Data Flexible Bitumen Seal

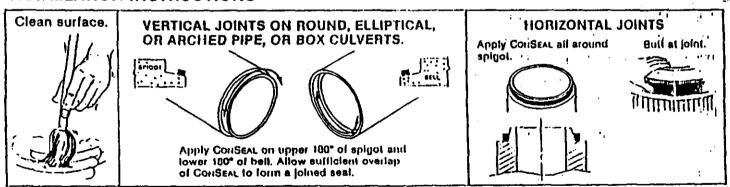
CS-102-B & CS-102-DO-B

CHEMICAL COMPOSITION	Spec	Required	CS-102-B & CS102-DO-B
Hydrocarbon plastic content % by weight	ASTM D4 (mod.)	50~70	52.1
inert mineral filler % by weight	SS-S-210A	30~50	· , 47.9
Volatile Matter % by weight	ASTM D6	3.0 max.	9 Herry 1.0

PHYSICAL PROPERTIES	, ¿. Spag	Required	CS-102-B & CS102-DO-B
Specific Gravity, 77°F	ASTM D71	11.20-1,35	清 [array 1.22]
Ductility, 77°F	ASTM D113		和期間時間 1
Softening point, ring and ball °F	ASTM D38	320° min.	李·李国第1370°€
Penetration, cone 77°F, 150 gm. 5 sec.	ASTM D217	50-120 mm	" '' lt l' v: 62 mm៉
Flash point, C.O.C., *F	ASTM D92	600° mln.	630°)
Fire point, C.O.C., °F	ASTM D92	625° min.	630°

Pay Immersion: No visible deterioration when tested for 30 days in 5%, caustic polash, 5% Hydrochloric Acid, Bulphuric Acid, or 5% saturated Hydrogen Sulfide.

INSTALLATION INSTRUCTIONS



LIMITED WARRANTY

The following limited warranty applies to our products and is in lieu of all warrantiles of neurchantability, litriess for purpose, or other warrantiles, express or implied; nely, that the product will be free of defects in workmanship or material, shall expire one year from the date of shipment and our limit of liability shall consist of ing available a replacement product. As we have no control of conditions under which this product may be used, or the methods of application thereof, userbuild test the product for their requirements.



AR001422

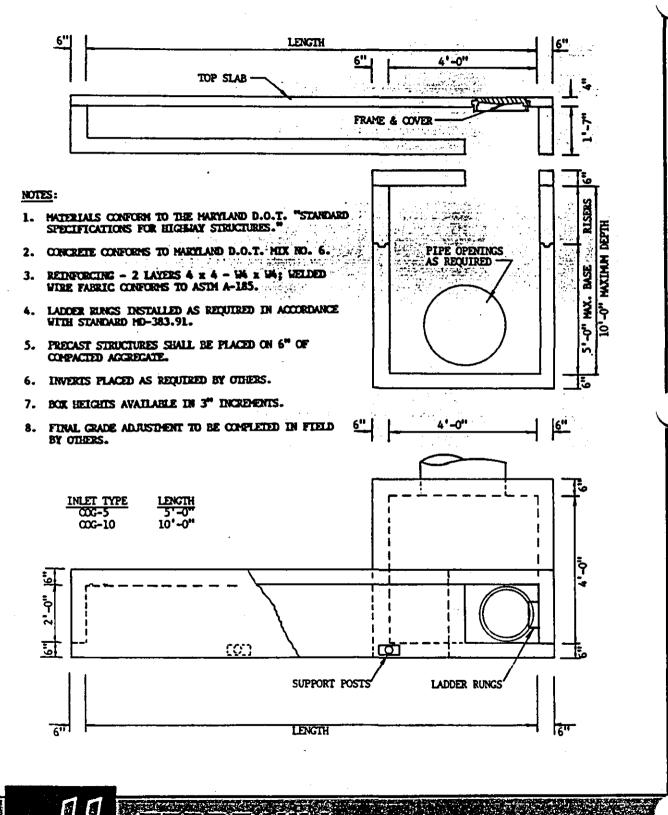


VENDOR INFORMATION

Pre-cast Inlet Boxes
Stormwater Inlet Grates

Precast C.O.G. Inlet

MARYLAND D.O.T.

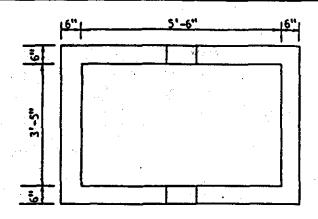




Terre Hill, PA 17581/(215) 445-6736

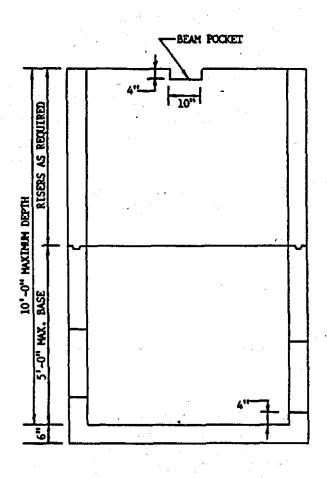
41" × 66" Precast Inlet Box

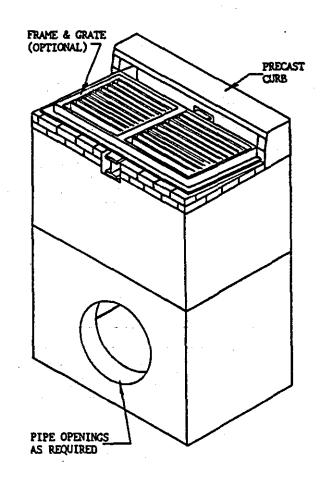
HOUSE THE PARTY OF
MARYLAND D.O.T. TYPE S COMBINATION DOUBLE GRATE TANDEM

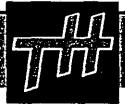


NOTES:

- 1. MATERIALS CONFORM TO THE MARYLAND D.O.T. "STANDARD SPECIFICATIONS FOR HIGHWAY STRUCTURES."
- 2. CONCRETE CONFORMS TO MARYLAND D.O.T. MIX NO. 6.
- 3. REINFORCING 2 LAYERS 4 x 4 W4 x W4; WELDED WIRE FARRIC CONFORMS TO ASTM A-185.
- 4. LADDER BURGS INSTALLED AS REQUIRED IN ACCORDANCE WITH STANDARD NO-383.91.
- FRECAST STRUCTURES SHALL BE PLACED ON 6" OF COMPACTED ACCREGATE.
- 6. INVEKTS PLACED AS REQUIRED BY OTHERS.
- 7. BOX HEIGHTS AVAILABLE IN 3" INCREMENTS.
- 8. FINAL GRADE ADJUSTMENT TO BE COMPLETED IN FIELD BY OTHERS.







TERRECOMMENTS

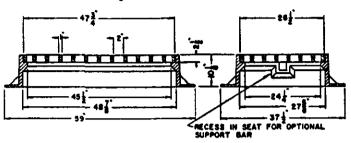
R-3572 4-Flange Gutter Inlet Frame and Diagonal Bar Grate

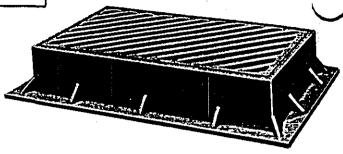
Heavy Duty

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Total Weight 1065 Pounds

Grate is reversible for right or left hand flow.





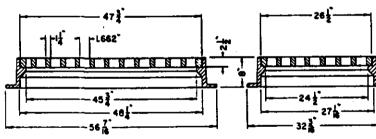
Also available with Type L grate as shown on R-3574-L.

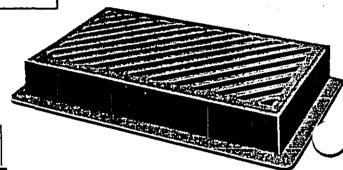
R-3573 3-Flange Gutter Inlet Frame and Diagonal Bar Grate

Heavy Duty

Total Weight 905 Pounds

Grate is reversible for right or left hand flow.





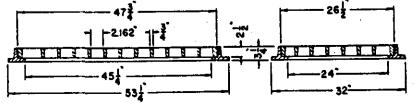
Also available with Type L grate as shown on R-3574-L.

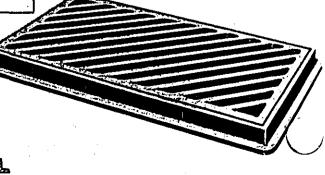
R-3574 4-Flange Area Drain Frame and Diagonal Bar Grate

Light Duty

Total Weight 465 Pounds

Grate is reversible for right or left hand flow.





AR001426

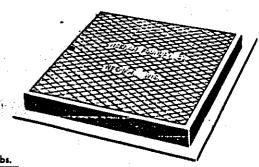
R-1878 Series Frames Heavy Duty Lids, Grates

rese shallow frames are suitable for use in thin or deep contributes are reversible and can be installed in flange at base or top.

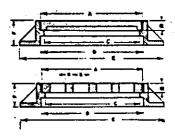
Specify:

- 1. Catalog number.
- 2. To be installed with flange at base or top.

Square			Đi	mensions	in inches					Wt.	Lbs.	
Catalog	Number	A	В	С	D	E	F	G	н	w/ lid	w/ grate	
Solid Lid	Open Grate				L 		_	·				
1-1878-ATL	R-1878-A1G	134 x 134	11/2	12 x 12	14 x 14	18 x 18	4	1 x 5 1/2		130	115	
t-1878-A2L	R-1878-A2G	18 x 18	11%	16 x 16	18¼ x 18¼	22 x 22	4	11/4 × 41/4	l i i		170	
R-1878-A3L	R-1878-A3G	20 x 20	11/2	18 x 18	20¼ x 20¼	24 x 24	4	115/1. x 374	i i		210	_
R-1878-A4L	R-1878-A4G	2114×2114	11/2	20 x 20	22 x 22	26 x 26		11/4×31/2	1	235	220	\
R-1878-A5L	R-1878-A5G	231/2 x 231/2	11%	22 x 22	24 x 24	28 x 28	4	1/2×61/2	34		300	_ \
R-1878-A6L		251/4×251/4		24 x 24	26 x 26	30 x 30	4	236×71/4	3.	330	280	
R-1878-A7L	R-1878-A7G	27½ × 27½	11/2	26 x 26	28 x 28	32 x 32	4	1×5	<u> </u>		325	
R-1878-ABL	R-1878-A8G	29% x 29%	11/2	28 x 28	29% x 29%	34 x 34	4	11/4×51/2	l i		485	
R-1878-A9L	R-1878-A9G	314 x 314	11/2	30 x 30	32 x 32	36 x 36	4	1×634	i i	470	465	
R-1878-A10L*	R-1878-A10G*	37 x 37	11/2	36 x 36	371/2 x 371/2	42 x 42	4	134×3½	11/2	790	700	
Rectangular							_					
R-1878-81L	R-1878-B1G	14 x 20	11/2	12 x 18	14¼ x 20¼	18 x 24	4	34×51/2	TT.	185	160	
R-1878-B2L	R-1878-82G	1315 x 2515	11/2	12 x 24	13¼ x 25¾	18 x 30	4	1 x 4 1/2	lı	220	185	
R-1078-B3L	R-1878-B3G	1915 x 2515	11/2	18 x 24	194 x 254	24 x 30	4	%×5	1	245	240	
R-1878-84L	R-1878-84G	1914 x 3114	11/2	18 x 30	20 x 32	24 x 36	7	2×5	1	265	249	
R-1878-85L	R-1878-85G		11/2	18 x 36		24 x 42		2×5	1	365	295	
R-1878-86L	R-1878-86G	25% x 31%	11/2	24 x 30	254 x 314	30 x 36	4	134×5	1	385	360	
1-1878-B7L	R-1878-87G		11/2	24 x 36	26 x 38	30 x 42	4	134 x 5	1	460	425	
R-1378-B8L*	R-1878-B8G*	25% × 49%		24 × 48				17/10×613/10	Ji.		575	
R-1878-89L*	R-1878-89G*			30 x 36	32 x 38	36 x 42		134 x 456	1	500	515	مر،
R-1878-810L*	R-1878-B10G*	311/2 x 491/2		30 x 48	31% x 49%	36 x 54	4	1!/2×43/4	1	695	680 🚄	_
Cover in two p	0001				42"	-	t	60'				



R-1878-ASL Manhole Frame and Solid Lid



Heavy Duty R-1878 Sections

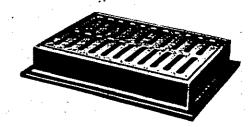
R-1879 Series Frames Light Duty Lids, Grates

These shallow frames are suitable for use in thin or deep concrete slabs. All sizes of frames are reversible and can be installed with flange at base or top.

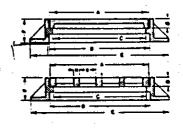
Specify:

- 1. Catalog number.
- 2. To be installed with flange at base or top.

Square			Di	mensions	in inches					H lid 115 165 144 165 144 165 144 165 144 145	
Catalog	A		С	Ь	Æ	F	G	н		w/ grat	
Solid Lid	Open Grate	1				*					-
R-1879-A1L	R-1879-A1G	13% x 13%	1%	12 x 12	14 x 14	18 x 18	4	1×3	\sqcap	115	100
R-1879-A2L	R-1879-A2G_	18 x 18	11%	16 x 16	18¼ x 18¼	22 × 22	4	34 x 456	34	165	150
R-1879-A3L	R-1879-A3G	20 x 20	11/2	18 x 18	20¼ x 20¼	24 x 24	4	34×5 €	3/4	195	185
R-1879-A4L	R-1879-A4G	2134×2134	11/2	20 × 20	22 x 22	26 x 26	4	34×4	74	200	185
R-1879-A5L	R-1879-A5G	2312×2312	11/2	22 x 22	24 x 24	28 x 28	4	34×61/2	1/4	235	255
R-1879-A6L	R-1879-A6G	25%×25%	11/2	24 x 24	26 x 26	30 x 30	4	1x5	34	245	215
R-1879-A7L	R-1879-A7G	2715×271/2	1 1/2	26 x 26	28 x 28	32 × 32	4	34×734	34	290	260
R-1879-A8L	R-1879-A8G	2914×2914	11%	28 x 28	29% × 29%	34 x 34	4	134 x 57/1	1	340	390
R-1879-A9L	R-1879-A9G	31%×31%	1%	30 x 30	32 x 32	36 x 36	4	1x41/4	34	360	310
R-1879-A10L*	R-1879-A10G*	37×37	1 1/2	36 x 36	37% x 37%	42 x 42	4	1x4%	1	485	445
Rectangular		•			:						
R-1879-B1L	R-1879-81G	14 x 20	%	12 x 18	1414 x 2014	18 x 24	4	34×5½		185	160
R-1879-82L	R-1879-82G	13½ x 25½	1%	12 × 24	13% x 25%	18 x 30	4	34 x 4 1/2	1	165	180
R-1879-83L	R-1879-83G	19½ x 25½	11/2	18 x 24	19¼ x 25¼	24 x 30	4	74×51/4	1	210	195
R-1879-84L	R-1879-B4G	19½ x 31½	1/2	18 x 30	20 x 32	24 x 36	4	34×5	ī	230	21:
4-1879-B5L	R-1879-B5G	19% x 37%	1 1/2	18 x 36	20 x 38	24 x 42	4	1%x5	1	295	310
879-B6L	R-1879-B6G	25% x 31%	11/2	24 x 30	25% x 31%	30 x 36	4	1x51/s	74	290	260
79-87L	R-1879-87G	25% x 37%	1/2	24 x 36	26 x 38	30 x 42	4	1x5%	3/4	335	29
479-B8L	R-1879-B8G	25¼ x 49¼	1%	24 x 48	26 x 50	30 x 54	4	34×51	1	395	40:
R-1879-89L*	R-1879-89G*	31% x 37%	145	30 x 36	32 x 38	36 x 42	4	1×6/2	1	400	380
R-1879-B10L*	R-1879-B10G*	311/2 x 491/2	14	30 x 48	3134 x 4934	136 x 54	4	1x5	lı i	480	425



R-1879-BIG Catch Basin Grate and Frame



Light Duty R-1879 Sections

不够要在一个人

Read Carefully Before Ordering



The various standard trench drains shown here are available with a number of alternates illustrated below. It is important to examine all of the variables carefully and specify fully your requirements. Your order will be entered correctly and promptly, if it includes this information:

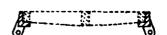
Specify:

- 1. Complete catalog number.
- 2. Frame end pieces, when required.
- 3. Type of grate or lid: A, C, D, E or P.
- 4. Length of trench.
- 5. PERMA-GRIP surface if required.

- 6. When extremely heavy loading is expected, such as concentrat fork-lift loads, heavy aircraft, etc., refer to Airport Trench section on page 170.
- 7. Special dimensions, such as changes in trench direction, etc. Se: details.
- 8. Pickholes or lift handles if required.
- 9. If trench drain grates are to be installed in bicycle traffic area please advise so that safety standards described on catalog page ? can be applied.

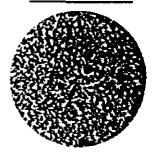
Standard Support Frame

Frames manufactured in standard lengths up to 36." Fractional frame sections can be furnished to produce a trench drain of any overall length. When necessary, frames can be closed at ends by specifying end frame sections.



TYPE X

PERMA-GRIP SURFACE



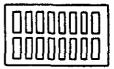
NEENAH's skid-resistant cover surface, PERMA-GRIP is now available as an alternate on many of our lid and grate styles.

PERMA-GRIP provides a rough cobbled type surface permitting positive traction which minimizes slippage.

Most flat cover or grate surfaces can be supplied with PERMA-GRIP in lieu of the illustrated style.

Standard Cover Types

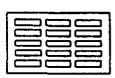
Grated and solid covers shown below are usually manufactured in standard maximum lengths of 24." They can be furnished in fractional sizes to fit any overall trench-length required. When ordering R-4990 or R-4991 trench drains, specify type of cover. Lift holes or handles are furnished on type D and E covers for trench widths larger than 10." See page 249.



TYPE A **GRATE OPENINGS**



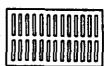
TYPE D SOLID CHECKERED TOP



TYPE C GRATE OPENINGS

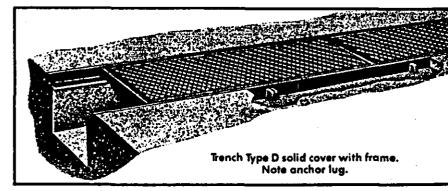


TYPE E SOLID PERFORATED TOP



TYPE P GRATE OPENINGS

Type Phave 14" s' and are especie cable for areas pedestrian traffic.



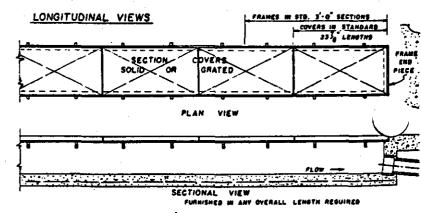
OPTIONAL — Boited Down Covers

In areas of fast heavy traffic, and in locations where vandalism is a problem, covers are frequently bolted to frames.

Grates and lids are bolted to frames with stainless steel cap screws.

Standard trench drains are not furnished bolted. If this feature is required on R-4990 series, see R-4999 series on page 234.

AR001428



R-4999 Series Bolted Transverse Drainage Structures

Duty

ating flat type surface showing type X frame and Type C grate.

Standard frame and cover sections of this type are bolted and manufactured in 24" standard lengths.

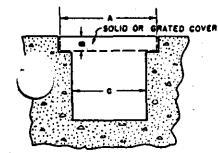
Read Carefully Before Ordering Specify:

- 1. Complete catalog number.
- 2. Length of structure.
- 3. Type of cover
- 4: Perma-Grip surface if required.
- (See page 229.)
 5. End frame sections and num-
- ber required per unit.
- 6 If trench drain grates are to be installed in bicycle traffic areas, please advise so that safety standards described on catalog page 89 can be applied.

When bolted frames and grates are furnished, they are shipped assembled. AT NO TIME SHOULD THE UNITS BE DISASSEMBLED DURING INSTALLATION!

Catalog	Dime	nsions in	inches	Weight per lineal foot (without frame)							
No.	A	В	C	Туре А	Type C	Type D	Type E	Type P	Frame**		
R-4999-AX	8	11/2	6	19	22	19	22	25	12		
R-4999-BX	10	11/2	8	24	27	29	27	31	12		
R-4999-CX	12	11/2	10_	28	31_	40	36	37	12		
R-4999-DX	14	13/2	12	33	35	52	47	45	12		
R-4999-EX	17	11/2	15	39	52	55	49	_	12		
R-4999-FX	20	11/2	18	54	67	70	70	_	12		
R-4999-GX	23	11/2	21	60	77	85	-		12		
R-4999-HX	26	11/2	24	71	100	85	l –	_	12		
R-4999-JX	30	2	27	100	120	100		<u> </u>	17		
R-4999-KX	33	2	30	110	140	150	-		17		
R-4999-LX	36	2	.33	120	130	185	_	_	- 17		
R-4999-MX	39	2	36_	130	200	180	<u></u>		17_		
R-4999-NX	45	2	42	150	245	210	_	_	17		
R-4999-OX	51	2	48	190	-	215	_	_	17		

**Weight per foot — includes both sides.







Grate Type A



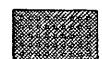
Grate Type C



Grate Type P



Solid Checkered Type D



Solid Perforated Type E

Type P grates have ¼" slot widths and are especially applicable for areas of heavy pedestrian traffic.

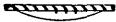
	FRAME TYPE	
		基
•	TYPE X	•

Catalog	Dime	nsions in	inches	Grate Wt. per
No.	A	В	C	lineal ft.
R-4999-L3	14	11/2	12	45*
R-4999-L6	24	2	22	88**
R-4999-L9	293/4	21/2	26%	115***

This series furnished standard with Type L grate shown at right.

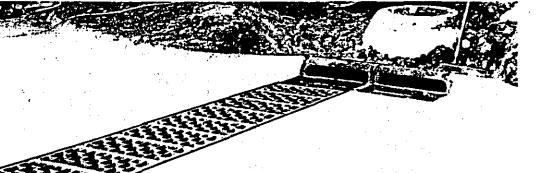
- *Furnished in 2 foot increments only.
- **Furnished in 1 or 2 foot increments only.
- ***Furnished in 1/2 or 3 foot increments only.





Grate Type L Available only on

#Justrating R-4999 bolted Prench series with Type L grate.



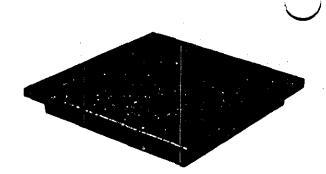
R-6672 — R-6673 Series

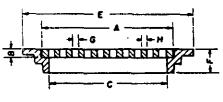
Square and Rectangular Frames and Grates

Heavy Duty - for Slab Construction

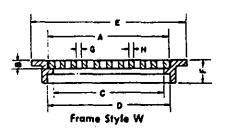
Suitable for drains in sidewalks, garages, laundries, service stations, bottling plants, industrial buildings, etc.





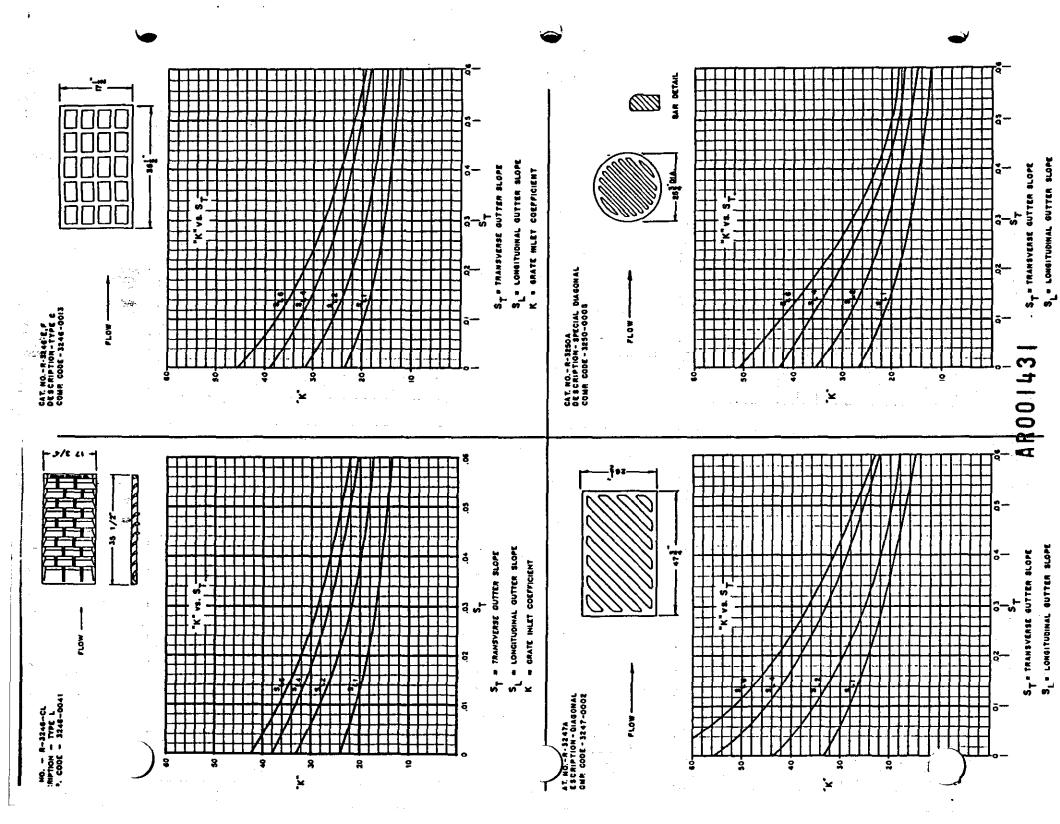


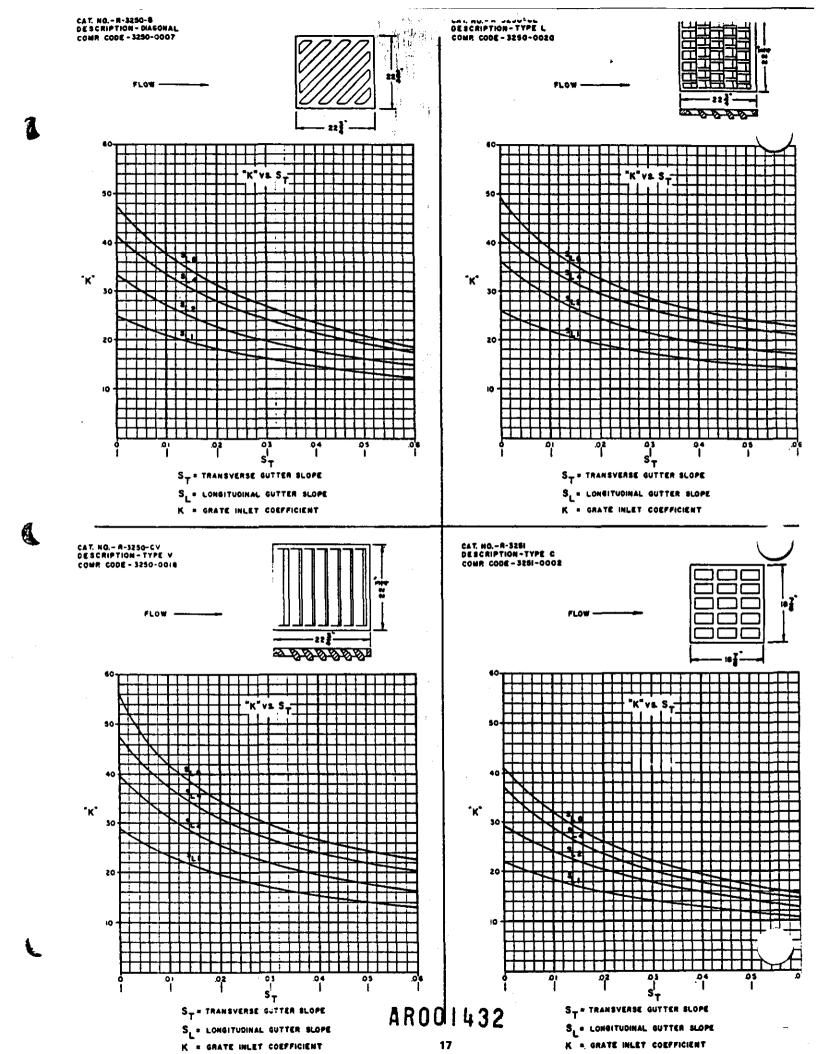
Frame Style Y

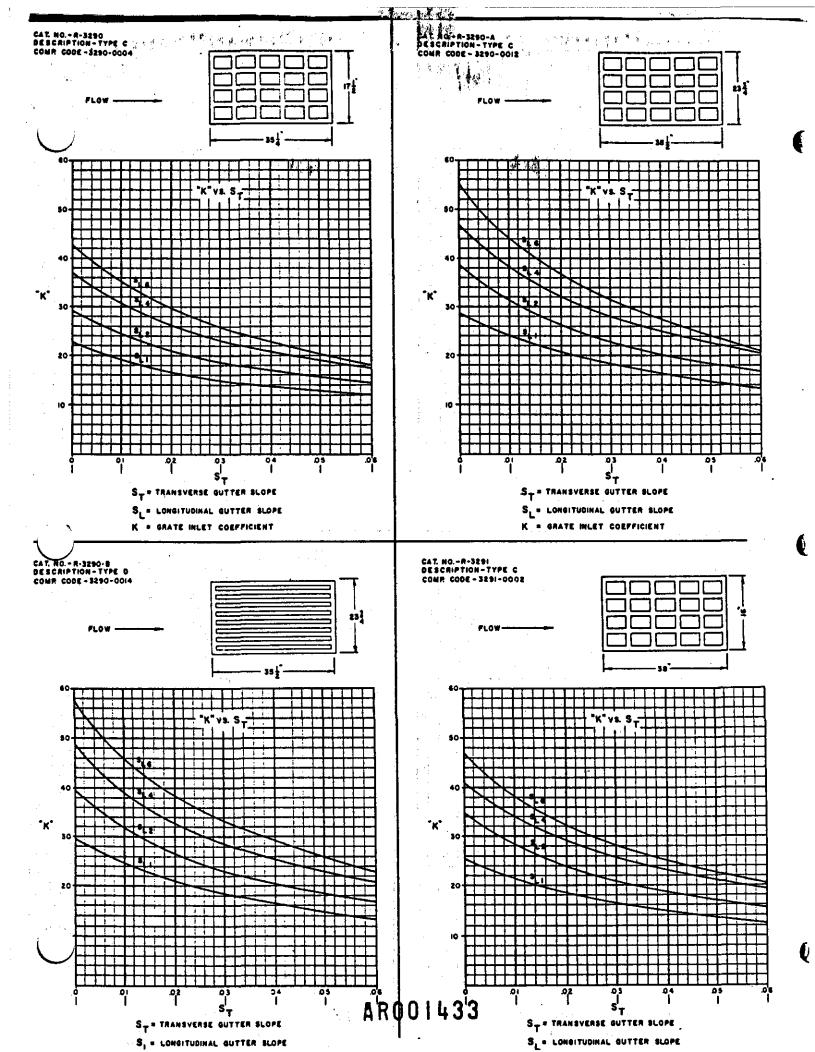


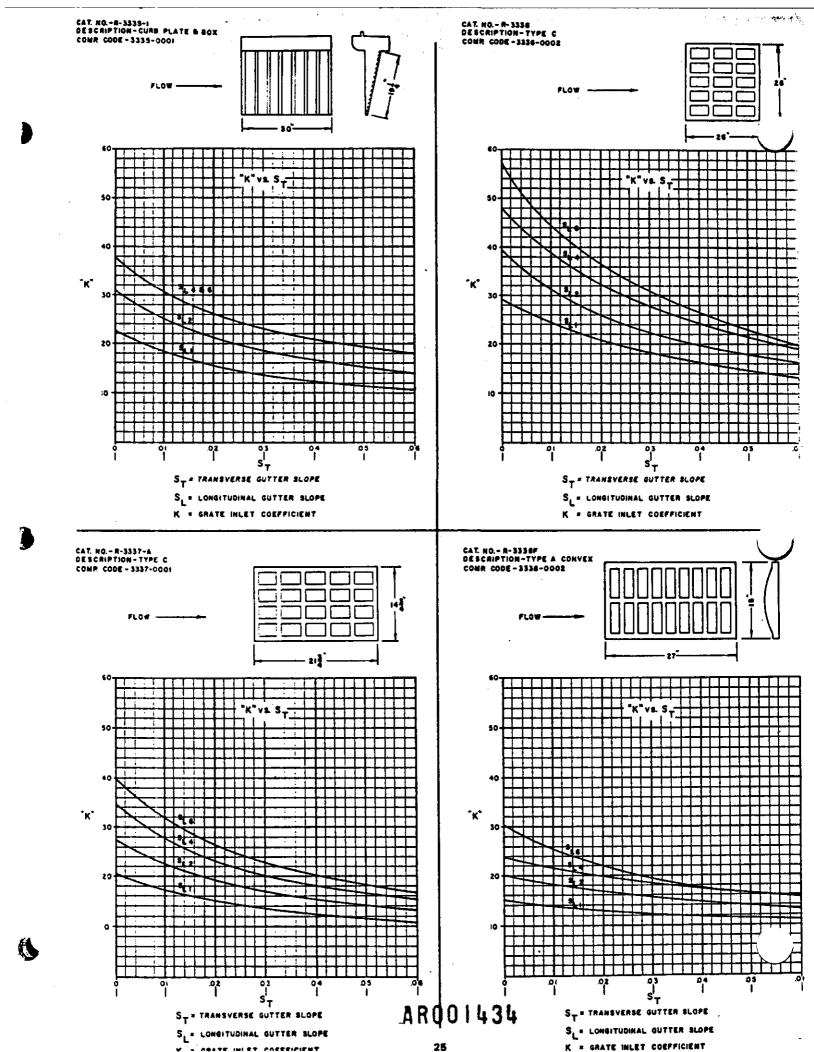
Catalog		Dimensions in inches									
No.	Α	В	U	٥	E	F	G	Н	Lbs.	Frame Type	
Square — Heav	y Duty										
R-6672-1 R-6672-A R-6672-B	11%×11% 12%×12% 13%×13%	1 1/4 1 1 1/2	10% x 10% 11% x 11% 12x 12 7	14x14	16x 16 15x 15 18x 18	3½ 6 4	1½×1½ 1½×10 1×5½	34 1 1	60 95 120	Y Y W	
R-6672-C R-6672-D R-6672-E	18 x 18 21 34 x 21 34 23 34 x 23 34	1½ 1½ 1½	16×16 20×20 22×22	22×22 24×24	24×24 26×26 28×28	4½ 4 4	1×4¼ 1¼×3½ 2¼×7%	1 1 1/4	155 220 315	Y	
R-6672-F R-6672-G R-6672-H	25¼ x 25¾ 27 x 27 27½ x 27½	1½ 2 1½	24×24 25×25 26×26	26×26 	30×30 33½×33½ 32×32	4 4	234×754 152×5 1×5	¥1 1 1	280 355 325	W Y W	
R-6672-J R-6672-K R-6672-M* R-6672-Q*Δ	30×30 31½×31¾ 37×37 56½×56½	1% 1% 1% 1%	28 x 28 30 x 30 36 x 36 54 x 54	 37½×37½	34×34 37×37 42×42 64×64	4 4 4 4½	1½×6 1×6 % 1¾×3½ 1½×12¾	11/4 1 11/2 11/4	440 475 700 1820	Y W Y	
Rectangular —	Heavy Duty			·			· .	·			
R-6673-A R-6673-B R-6673-C	14×20 13½×25½ 19½×25½	1½ 1½ 1½	12×18 12×24 18×24	14¼×20¼ 13¾×25¾ 19¾×25¾	18×24 18×30 24×30	4 4 4	1/4×51/2 1×41/2 1×67/6	1 1 1	165 185 240	**	
R-6673-D R-6673-E R-6673-J	1914×3114 1914×3714 251/2×311/2	1½ 1½ 1½	18×30 18×36 24×30	20×32 20×38 25¾×31¾	24×36 30×42 30×36	4 4	2×5 2×5 1¾×5	1	250 295 360	**	
R-6673-K R-6673-L* R-6673-N*	25%×37% 25%×49% 31%×37%	1½ 1½ 1½	24×36 24×48 30×36	26×38 26×50 32×38	30×42 30×54 36×42	4 4	136×5 15/4×6 ¹³ /4 136×456	1 1 1	425 580 515		
R-6673-O* R-6673-Q*∆	31½×49½ 38×50	11/2	30×48 36×48	31% x 49% 38% x 50%	36×54 44½×56½	4	1½×4¾ 1¾×6	1	680 735	W	

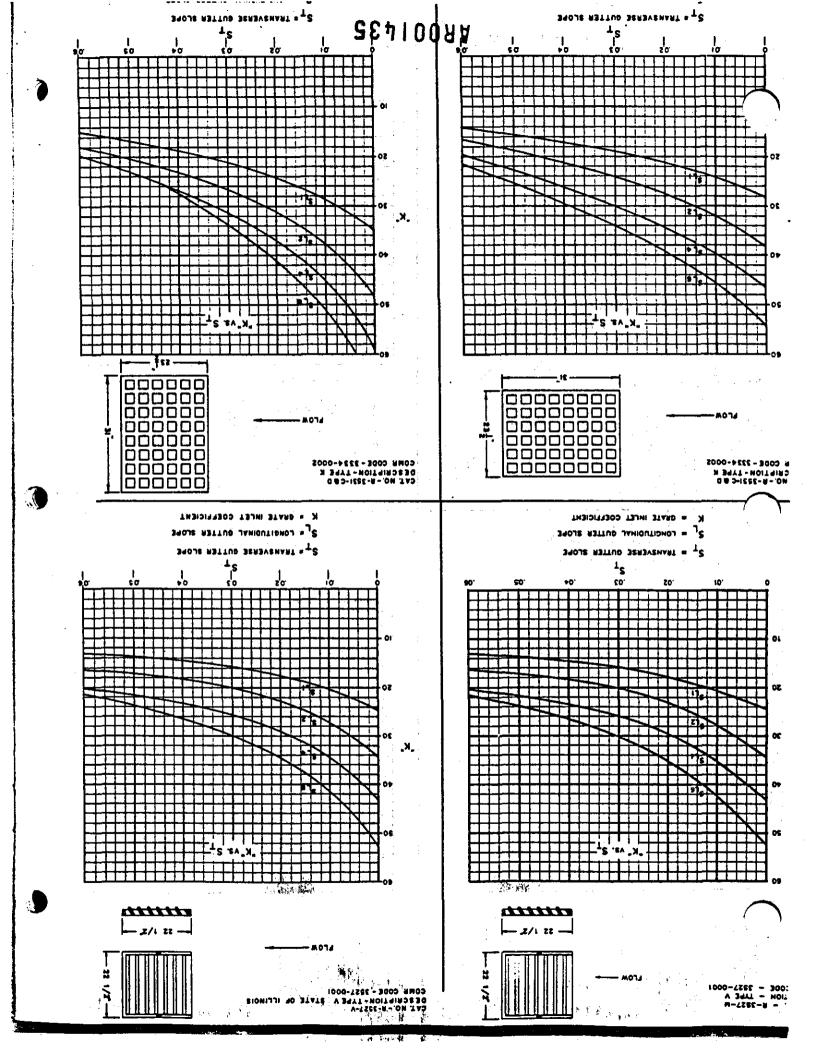
⊗ Not recommended for bicycle traffic. For safety standards see pages 88 to 93. *Grate in two pieces. △Frame in sections, Bolted in corners.











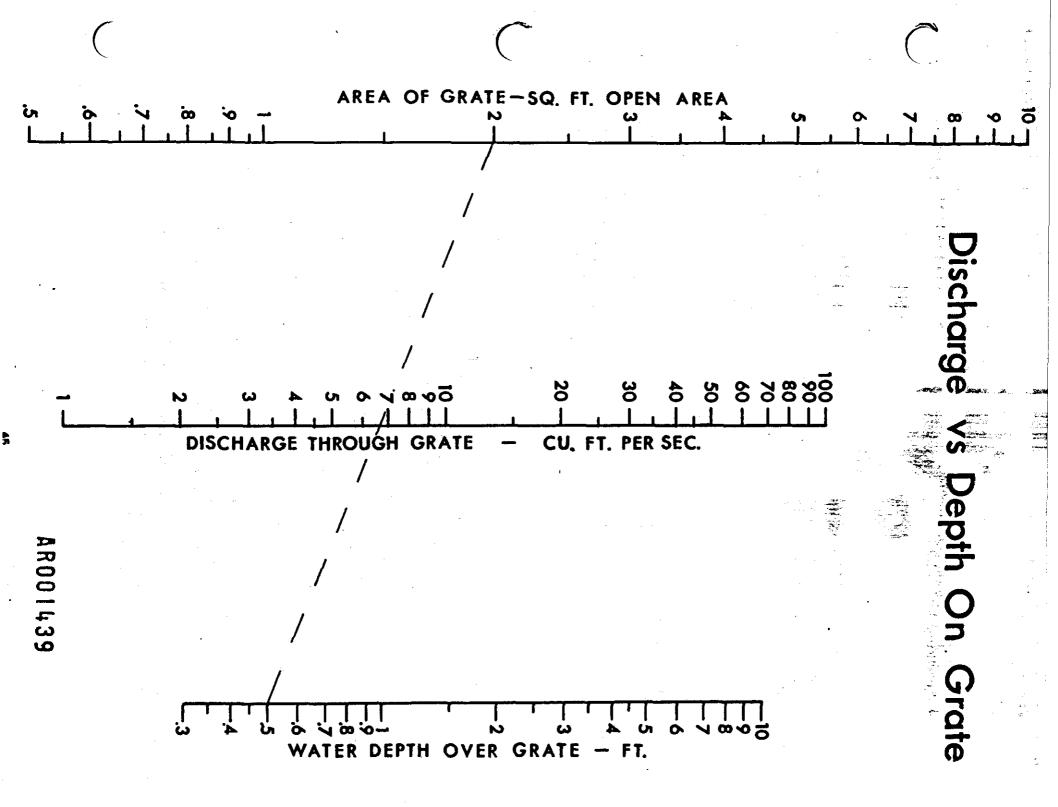
CAT. NO. - R-3570 DESCRIPTION - TYPE A COMP. CODE - 3570-0002 CAT. NO. - R-3675 DESCRIPTION-DIAGONAL REVERSIBLE COMR CODE - 3873-0002 FLOW -FLOW . 40 SŢ ST = TRANSVERSE GUTTER SLOPE $S_T = TRANSVERSE GUTTER SLOPE$ = LONGITUDINAL GUTTER SLOPE S . LONGITUDINAL GUTTER SLOPE - GRATE INLET COEFFICIENT K . GRATE INLET COEFFICIENT CAT. NO.-R-3574
DESCRIPTION-TYPE R DIAGONAL REVERSIBLE
COMP. CODE-3574-0002 CAT. NO. - R-3874-L DESCRIPTION - PENM. DOT TYPE L COMP. CODE - 3573-0006 FLOW -**27777777777** "K" 20 ۵3, ST ST = TRANSVERSE GUTTER SLOPE ST = TRANSVERSE GUTTER SLOPE - LONGITUDINAL GUTTER SLOPE S. . LONGITUDINAL GUTTER SLOPE

GRATE INLET COEFFICIENT

CAT. NO.- R-4016-E DESCRIPTION-TYPE & CAT. NO. - R-4710 DESCRIPTION-TYPE A COMP. CODE - 4710-4000 COMR CODE - 4016-0005 FLOW . 40 20 ST . TRANSVERSE GUTTER SLOPE ST = TRANSVERSE GUTTER SLOPE S . . LONGITUOINAL GUTTER SLOPE S = LONGITUDINAL GUTTER SLOPE K . GRATE INLET COEFFICIENT K . GRATE INLET COEFFICIENT CAT. NO.-R-4710 DESCRIPTION-TYPE C COMP. CODE-4710-4000 40 20

ST = TRANSVERSE GUTTER SLOPE
St = LONGITUDINAL GUTTER SLOPE

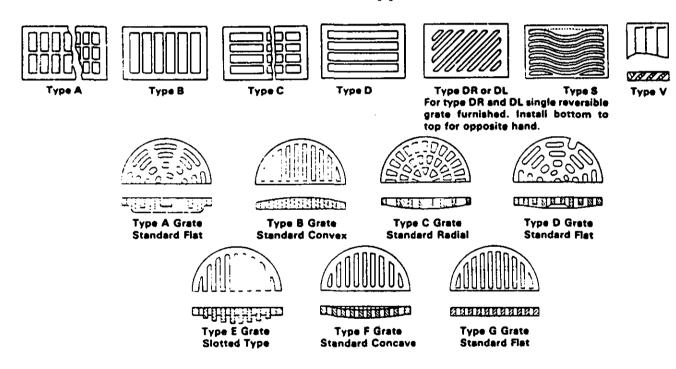
AR001438



INFORMATION ON NEENAH GRATES

The following pages list the Neenah catalog designs furnished with grates. In addition to the free opening areas which are necessary to determine the discharge, the tables also show the grate type or style which are shown below for easy identification.

Grate Types



Special notes on Neenah grate types.

- 1. Type K indicates "Special" grate design and is not among standard types as illustrated.
- Inlet grate type A or C can vary depending on how it is installed. If grate is installed with long side of openings perpendicular to flow, it is a type A grate, and if grate is installed with long side of openings parallel to flow, it is a type C grate.
- 3. Inlet grate type B or D can vary depending on how it is installed. If grate is installed with long slots perpendicular to flow, it is a type B grate, and if grate is installed with long slots parallel to flow, it is a type D grate.

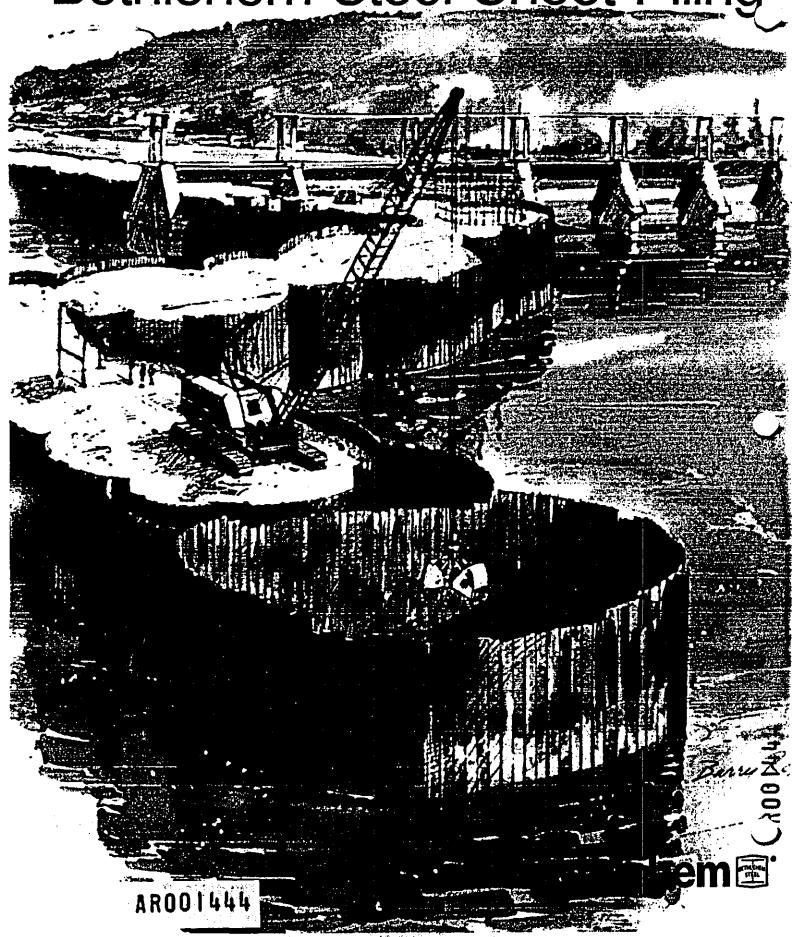
APPENDIX 5

Sheet Pile Wall Information

VENDOR INFORMATION

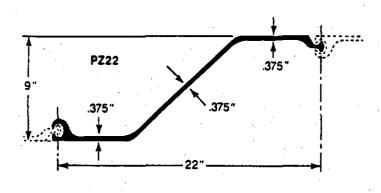
Steel Sheet Piling

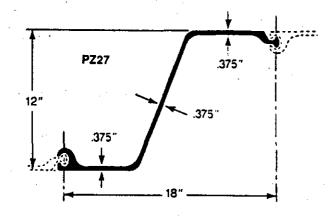
Bethlehem Steel Sheet Piling

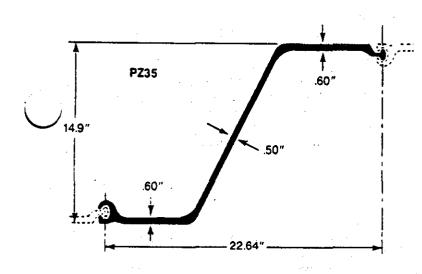


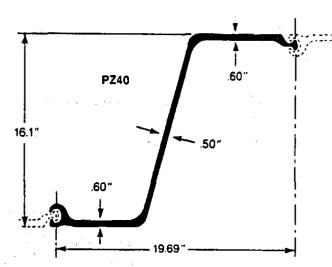


Sections designed for bending strength (See page 6 for Z-piling data)



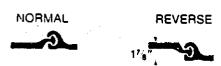






Interlocking

Because ball and socket dimensions are the same for all Bethlehem Z-piling sections, all Z-piling sections can interlock with one another. Also, because of the shape of the interlock, they can be joined in either of two arrangements.

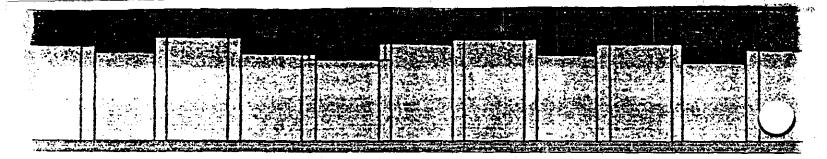


Sections Which Interlock With Each Other

PZ22	PZ27	PZ35	PZ40
	PS.	23*	
 P	S27.5	PS	31

^{*}See page 8 for information on interlocking PSA23 with Bethlehem Z-piling.

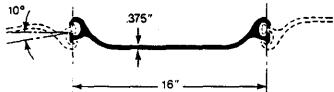
Sections PS27.5 and PS31 will interlock with each other, but will not interlock with any other section.

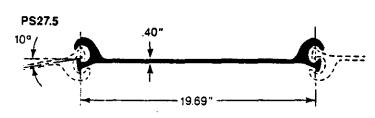


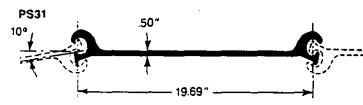
Sections designed for interlock strength

(See page 22 for data on cellular design)

PSA23







Interlock strength:

PSA23, when properly interlocked, develops a minimum ultimate interlock strength of 12 kips per in. Excessive interlock tension results in web extensions for section PSA23. Therefore, the interlock tension for this section should be limited to a maximum working load of 3 kips per in.

PS27.5 and PS31, when properly interlocked, develop a minimum ultimate interlock strength of 16 kips per in. If a greater interlock strength is required, see page 23.

Swing:

PSA23, PS27.5 and PS31. when properly interlocked, are designed for a minimum swing of up to 10 degrees (in either direction) for lengths up to 70 ft. The ability to obtain a full 10 degree swing decreases because of the difficulty in handling the longer pieces. With longer pieces, it is necessary to anticipate a reduction in obtainable swing of 1.5 degrees for each 10 ft increase in length over 70 ft.

Properties and Weights

			Weight i	n Pounds	Moment of	Section M	odulus in. ³		urface Area per lin. ft of bar
Section Designation	Area sq in.	Nominal Width, in.		Per sq ft of wall		Single Section	Per lin. ft of wall	Total Area	Nominal Coating Area*
PZ22	11.86	22	40.3	22.0	154.7	33.1	18.1	4.94	4.48
PZ27	11.91	18	40.5	27.0	276.3	45.3	30.2	4.94	4.48
PZ35	19.41	22.64	66.0	35.0	681.5	91.4	48.5	5.83	5.37
PZ40	19.30	19.69	65.6	40.0	805.4	99.6	60.7	5.83	5.37
PSA23	8.99	16	30.7	23.0	5.5	3.2	2.4	3.76	3.08
PS27.5	13.27	19.69	45.1	27.5	5.3	3.3	2.0	4.48	3.65
PS31	14.96	19.69	50.9	31.0	5.3	3.3	2.0	4.48	3.65

^{*} Excludes socket interior and ball of interlock.

Dimensions:

The dimensions shown on these pages are nominal. (See pages 10 and 25 for dimensions for detailing.)

Steel Grades:

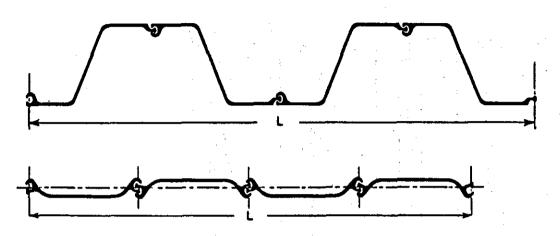
Bethlehem steel sheet piling can be supplied in standard ASTM A328 and in high-strength, low-alloy grades ASTM A572 - Grades 50 and 60 and ASTM A690.

Impact Resisting Steel:

Bethlehem steel sheet piling can be supplied to meet Charpy (CVN) requirements. (See page 35 for further information.)



Wall Lengths Formed with Bethlehem Sheet Piling



Number	PSA23 16* = 1.3333'	PZ22 22" = 1.8333'	PZ27 18" = 1.50'	PZ35 22.64" = 1.8867'	PZ40, PS27.5 & PS31 19.69" = 1.6408'
of Pieces	L (length), feet	L (length), feet	L (length), feet	L (length), feet	L (length), feet
1	1.33	1.83	1.50	1.89	1.64
1 2 3 4	2.67	3.67	3.00	3.77	3.28
3 (4.00	5.50	4.50	5.66	4.92
4.1	5.33	7.33	6.00	7.55	6.56
5 6 7 8 9	6.67	9.17	7.50	9.43	8.20
ğ	8.00	11.00	9.00	11.32	9.85
7	9.33	12.83	10.50	13.21	11.49
2 1	10.67 12.00	14.67	12.00 13.50	15.09	13.13 14.77
10	13.33	16.50 18.33	15.00	16.98 18.87	16.41
ii	14.67	20.17	16.50	20.75	18.05
12	16.00	22.00	18.00	22.64	19.69
13	17.33	23.83	19.50	24.53	21.33
14	18.67	25.67	21.00	26.41	22.97
iš l	20.00	27.50	22.50	28.30	24.61
iĕ l	21.33	29.33	24.00	30.19	26.25
iř	22.67	31.17	25.50	32.07	27.89
18	24.00	33.00	27.00	33.96	29.54
19	25.33	34.83	28.50	35.85	31.18
20	26.67	36.67	30.00	37.73 39.62	32.82
21	28.00	38.50	31.50	39.62	34.46
22	29.33	40.33	33.00	41.51	36.10
23	30.67	42.17	34.50	43.39	37.74
- 24	32.00	44.00	36.00	1 45.28	39.38
25	33.33	45.83	37.50	47.17	41.02
26	34.67.	47.67	39.00	49.05	42.66
27	36.00	49.50	40.50	1 50.94	44.30
28	37.33	51.33	42.00	52.83	45.94
29	38.67	53.17	43.50	54.71	47.58
30	40.00	55.00	45.00	56.60	49.23
31	41.33	56.83	46.50	58.49	50.87
32	42.67	58.67	48.00	60.37	52.51
33	44.00	60.50	49.50	62.26	54.15
34	45.33	62.33	51.00	64.15	55.79
35	46.67	64.17	\$2.50	66.03	57.43
36 37	48.00	66.00	54.00	67.92	59.07
38	49.33	67.83	55.50	69.81	60.71
38	50.67	69.67	57.00	71.69	62.35
40	52.00	71.50	58.50	73.58	63.99
41	53.33 54.67	73.33	60.00	75.47	65.63
42	54.67 56.00	75.17 77.00	61.50	77.35	67.27 68.92
43	57.33	78.83	63.00 64.50	79.24	70.56
44	57.33 58.67	80.67	66.00	81.13 83.01	72.20
45	60.00	82.50	67.50	84.90	73.84
70	00.00	D2.3V	01.00	J 04.50	1 10.04

Note:
The length of walls tabulated are based on catalog widths of the piling sections. The usual mill variations in rolling the sections and particularly the methods used in setting and driving may cause deviation from the lengths shown.

Number of	PSA23 16" = 1.3333'	PZ22 22" = 1.8333'	PZ27 18" = 1.50'	PZ35 22.64" = 1.8867'	PZ40, PS27.5 & PS3 19.69" = 1.6408'
Pieces	L (length), feet	L (length), feet	L (length), feet	L (length), feet	L (length), feet
46	61.33	84.33	69.00	86.79	75.48
47 48	62.67 64.00	86.17 88.00	70.50 72.00	88,67 90,56	77.12 78.76
49	65.33	89.83	73.50	92.45	80.40
50	66.67	91.67	75.00	94,33	82.04
51 52	68.00 69.33	93.50 95.33	76.50 78.00	96.22 98.11	83.68 85.32
53	70.67	97.17	79.50	99.99	86.96
`54 55	72.00 73.33	99.00	81.00	101.88	88.61 90.25
56	74.67	100.83 102.67	82.50 84.00	103.77 105.65	91.89
57	76.00	104.50	85.50	107.54	93.53
58 59	77.33 78.67	106.33 108.17	87.00 88.50	109.43 111.31	95.17 96.81
60	80.00	110.00	90.00	113.20	98.45
61	81.33	111.83	91.50	115.09	100.09
62 63	82.67 84.00	113.67 115.50	93.00 94.50	116.97 118.86	101.73 103.37
64	85.33	117.33	96.00	120.75	105.01
65	86.67	119.17	97.50	122.63	106.65
66 67	88.00 89.33	121.00 122.83	99.00 100.50	124.52 126.41	108.30 109.94
68	90.67	124.67	102.00	128.29	111.58
69	92.00	126.50	103.50	130.18	113.22
70 71	93.33 94.67	128.33 130.17	105.00 106.50	132.07 133.95	114.86 116.50
72	96.00	132.00	108.00	135.84	118.14
73	97.33	133.83	109.50	137.73	119.78
74 75	98.67 100.00	135.67 137.50	111.00 112.50	139.61 141.50	121.42 123.06
76	101.33	139.33	114.00	143.39	124.70
77	102.67	141.17	115.50	145.27	126.34 127.99
78 79	104.00 105.33	143.00 144.83	117.00 118.50	147.16 149.05	127.99
80	106.67	146.67	120.00	150.93	131.27
81	108.00	148.50	121.50	152.82	132.91 134.55
82 83	109.33 110.67	150.33 152.17	123.00 124.50	154.71 156.59	136.19
84	112.00	154.00	126.00	158.48	137.83
85 86	113.33	155.83 157.67	127.50 129.00	160.37	139.47
87	114.67 116.00	159.50	130.50	162.25 164.14	142.75
88	117.33	161.33	132.00	166.03	144.39
89 90	118.67 120.00	163.17 165.00	133.50 135.00	167.91	146.03
91	120.00	166.83	136.50	169.80 171.69	149.32
92	122.67	168.67	138.00	173.57	150.96
93	124.00	170.50	139.50	175.46	152.60
94 95	125.33 126.67	172.33	141.00	177.35	155.88
96	128.00	176.00	144.00	181.12	157.52
97 98	129.33 130.67	177.83 179.67	145.50 147.00	183.01 184.89	159.16 160.80
99	132.00	181.50	148.50	186.78	162.44
100	133.33	183.33	150.00	188.67	164.08
200	266.67	366.67	300.00	377.33	328.17
300 400	400.00 533.33	550.00 733.33	450.00 600.00	566.00 754.67	492.25 656.33
500	666.67	916.67	750.00	943.33	820.42
600	800.00	1100.00	900.00	1132.00	984.50
700 800	933.33 1066.67	1283.33 1466.66	1050.00 1200.00	1320.67 1509.33	1148.58 1312.66
900	1200.00	1650.00	1350.00	1698.00	1476.75
1000	1333.33	1833.33	1500.00	1886.67	1640.83
2000	2666.67	3666.67	3000.00	3773.33	3281.67

Note:
The length of walls tabulated are based on catalog widths of the piling sections. The usual mill variations in rolling the sections and particularly the methods used in setting and driving may cause deviation from the lengths shown.

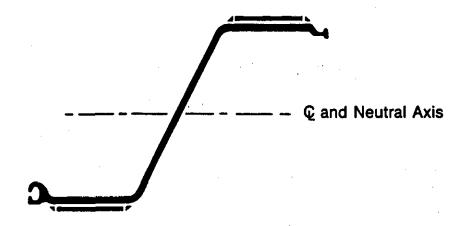
There may be occasions when even PZ40 in high-strength grades of steel is not sufficiently strong to satisfy the calculated design moments. When this is the case, the designer has several available options to consider:

Cellular Design

This design can be very efficient and an option that should be explored for facilities such as deep draft bulkheads and large graving docks. Cellular construction provides a solid-faced wharf in deep water without the need for elaborate anchorage systems. The feasibility of a cellular design is somewhat dependent on site and soil conditions. Refer to page 22 for additional information on cellular design.

Cover Plated Z-Piling

This approach extends the range of Z-piling by increasing the moment carrying capacity in the area where the design moment exceeds the capacity of the plain Z-pile.



	PZ35	3	PZ40)
Plate Size (in.)	Section Modulus in. ³ /ft of wail	Weight lb/ft ² of wall	Section Modulus in. ³ /ft of wall	Weight lb/ft ² of wall
None	48.5	35.0	60.7	40.0
$4-1/2 \times .25$	-	_	70.2	44.7
$4-1/2 \times .375$	_	_	74.8	47.0
$4-1/2 \times .50$	63.2	43.1	79.5	49.3
$4-1/2 \times .625$	67.0	45.1	84.2	51.7
$4 \cdot 1/2 \times .75$	70.8	47.2	89.0	54.0
4-1/2 × .875	74.6	49.2	93.7	56.3
$4-1/2 \times 1.00$	78.4	51.2	98.5	58.6
$4 - 1/2 \times 1.125$	82.3	53.2	103.4	61.0
$4-1/2 \times 1.25$	86.2	55.3	108.3	63.3

Note:

- Filet weld should be sized to adequately resist design loads and should be continuous and all around.
- Cover plate length depends upon moment curve.
- Weight shown in lb ft² of wall is for the section in the cover-plated location. The average weight in lb/ft² of wall will be lower.

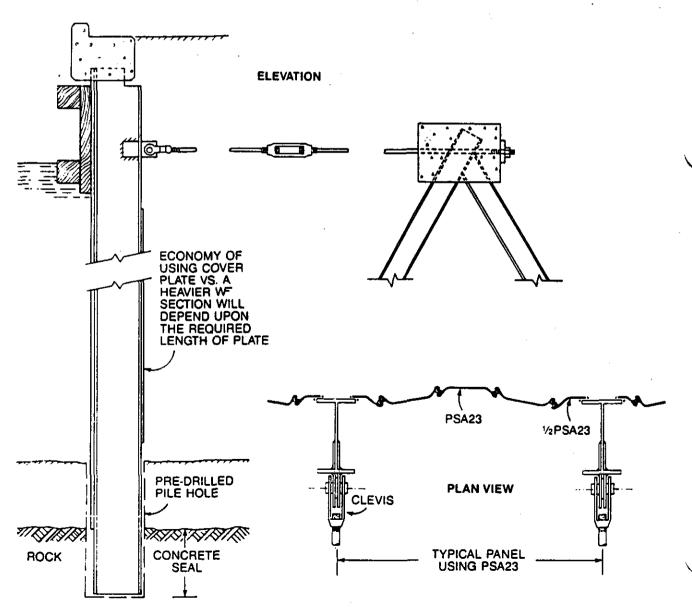
AR001449

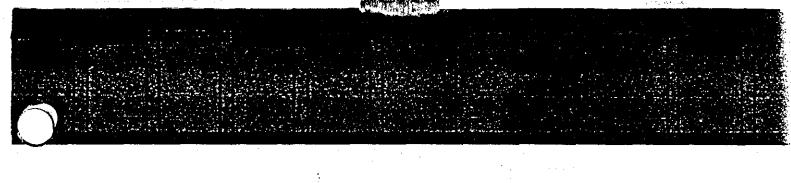
Master Pile System

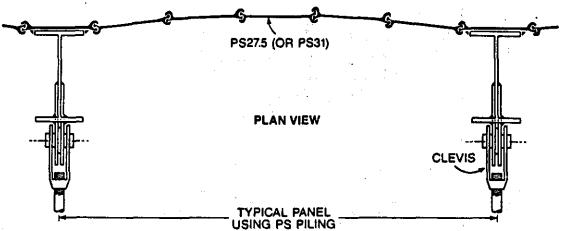
This system combines moment resisting and cellular design. The PSA or PS sheet piling sections transmit the soil pressures on the arcs by interlock tension to the moment-resisting master piles.

A master pile design is ideally suited to sites where very hard driving is anticipated or rock is at a high elevation and sufficient penetration is not available for adequate toe resistance. In such cases, the master pile can be installed in a predrilled hole and grouted in place.

Depending on the number of intermediate sheets, section moduli in excess of 200 in.³/ft of wall can be obtained utilizing this design concept.







The following table, using selected wide-flange sections (unreinforced and reinforced), shows design properties obtainable using this approach. This table should be used by the designer as a guide. Actual master pile size and system geometry (master pile spacing, arc radius, etc.) must be determined by the engineer based on site conditions. Connection details are extremely important and must be designed with care.

	· · · · · · · · · · · · · · · · · · ·		Intermed	liate Piles			
Master Pile		3 Sections PSA23		5 Sections PS27.5 (or PS31)			
	Spacing L	Section Modulus in.3/ft of wall	Weight lb/ft² of wall	Spacing L	Section Modulus in. ³ /ft of wall	Weight lb/ft ² of wall	
W14×132	6'-0"	36.6 (51.4)	42.4	9'-8"	23.8 (35.0)	41.7	
W14×257	6' • 3"	69.2 (81.5)	60.7	9' • 8"	46.4 (54.8)	54.6	
W14×342	6'-3"	92.9 (104.1)	74.5	9'-8"	62.1 (68.9)	63.5	
W24×162	6'-0"	72.7 (99.9)	47.4	9' - 8"	46.8 (68.8)	44.8	
W27 × 178	6'-0"	88.1 (118.4)	50.0	9'-8"	56.5 (81.2)	46.4	
W33×152	5'-9"	90.7 (130.7)	47.7	9'-8"	56.0 (88.5)	43.7	
W36×135	5'-9"	83.0 (126.2)	44.7	9' - 8"	51.5 (87.1)	42.0	
W36×170	5'-9"	107.8 (150.6)	50.8	9' - 8"	66.5 (101.2)	45.6	
W36×210	5'-9"	132.6 (174.3)	57.8	9'-8"	81.5 (114.9)	49.7	
W36×260	6' • 3"	158.7 (195.3)	61.2	10'-6"*	96.8 (125.3)	50.6	
W36×300	6'-3"	183.2 (219.0)	67.6	10'-6"*	111.6 (138.9)	54.4	

^{*}PS pile is attached in 2 pieces.

AR001451

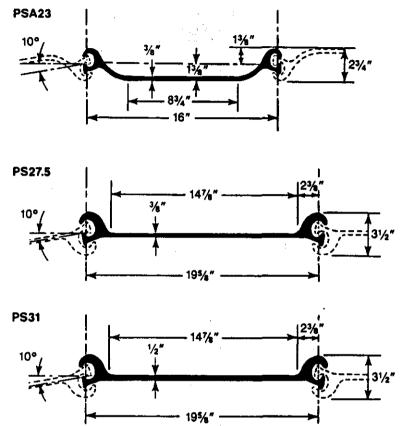
Numbers in parentheses represent section moduli with cover plates on the back of the master piles.

☐ Numbers in parentheses represent section moduli with cover plates on the back of the master piles.

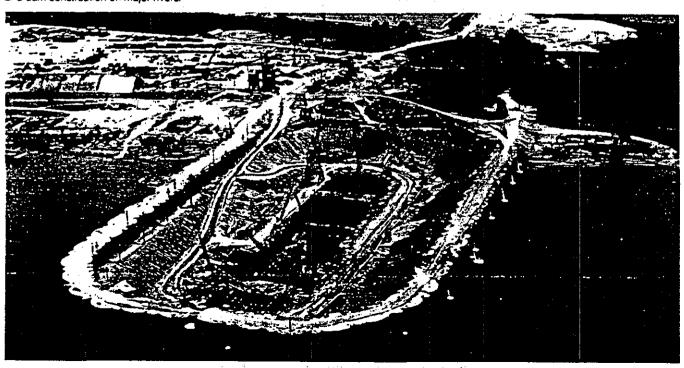
☐ The plate Imeasuring 9 in. × 1 in. for a PSA23 layout and 10½ in. × 1½ in. for a PS27.5 layout) is welded continuously all around. The weld must be sized to resist the design loads.

☐ All welds are continuous and all around.

Dimensions for Detailing



PS-type, long-length sheet piling enables very deep cofferdams to be built for lock and dam construction on major rivers.

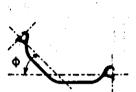


AR001452

Standard Fabricated Connections Used with PSA23

Bent Web Piles

BW230 30.7 lb/ft

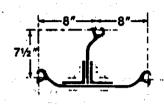


BW231 30.7 lb/ft

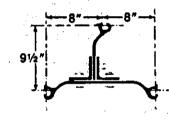


90° T Piles

FT230 69 lb/ft

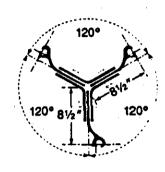


FT231 69 lb/ft



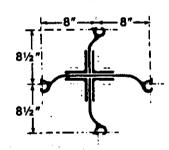
120° Y Piles

FY234 90 lb/ft



Cross

FX230 103 lb/ft



Notes:

 \square Standard angle: 3-1/2 \times 3-1/2 \times 3/8 in.

 \square Standard bent plate size for 120° Y: 3/8 × 10 in.

☐ Fasteners are 7/8-in. high-strength bolts spaced on 6-in. centers throughout the length of the section, except for 2 ft at each end where they are located on 3-in. centers.

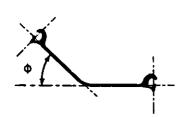
☐ A different arrangement of the interlocks is obtained by reversing the connections end for end.

See General Specifications (page 34) for additional information.

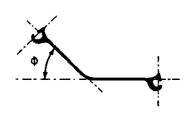
Standard Fabricated Connections Used with PS27.5 or PS31 With specified interlock strength of 16 kips/in.



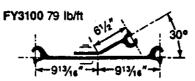
BW2750 45.1 lb/ft BW3100 50.9 lb/ft

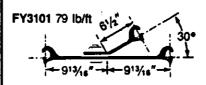


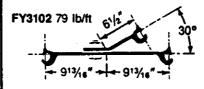
BW2751 45.1 lb/ft BW3101 50.9 lb/ft

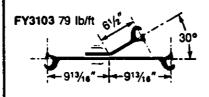


30° Y Piles



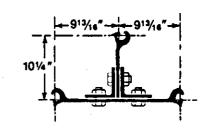




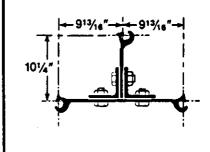


90° T Piles

FT3100 118 lb/ft



FT3101 118 lb/ft



Notes:

- ☐ It is suggested that the designer consider using section PS31 for all fabricated connections. The connections shown on this page are based on using PS31.
- ☐ Angles, plates and bolts are as follows:

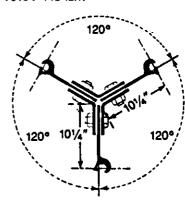
Connection	Angle in.	Bent Plate in.	Bolt Diameter in.
30°Y	_	_	7/8
90°T	5×5×½	_	7/8
120°Y	_	10½×½	1

- ☐ Angles and plates will be furnished in ASTM A36 steel.
- ☐ Fasteners are high-strength ASTM A325 bolts, with washers, spaced on 4½-in. centers throughout the length of the section, except for the last 2 ft at each end where they are located on 3-in. centers.
- ☐ A different arrangement of the interlock is obtained by reversing the connection end for end.

See General Specifications (page 34) for additional information.

120° Y Pile

FY3104 143 lb/ft

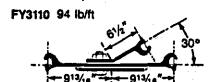


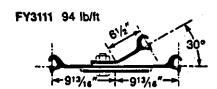
Standard Fabricated Connections

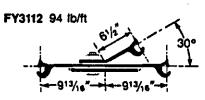
Used with PS27.5 or PS31

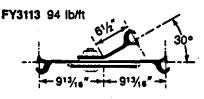
With specified interlock strength of 20 kips/in. or 24* kips/in.

30° Y Piles

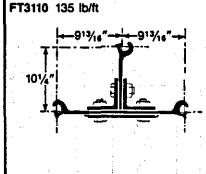


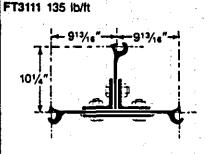






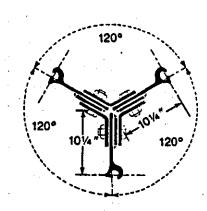
90° T Piles





120° Y Piles





Notes:

- ☐ It is suggested that the designer consider using section PS31 for all fabricated connections. The connections shown on this page are based on using PS31.
- Angles, plates and bolts are as follows:

Connection	Angle in.	Bent Plate in.	Reinforcing Plate in.	Bolt Diameter in.
30°Y		_	10½×3/8	1
90°T	5×5×1/2	_	10½×¾	1
120°Y	_	10½×½	5×3/8	1 1/8

- ☐ Angles and plates will be furnished in ASTM A36 steel.
- ☐ Fasteners are high-strength ASTM A325 bolts, with washers, spaced on 4½-in. centers throughout the length of the section, except for the last 2 ft at each end where they are located on 3-in. centers.
- ☐ A different arrangement of the interlock is obtained by reversing the connection end for end.

See General Specifications (page 34) for additional information.

*Not available in PS27.5. See page 23 for information on interlock strength.

AR00145

Diameters and Areas of Circular Cells Using PSA23, PS27.5 and PS31



Number	PS/	A 23	PS27.5	& PS31	Required*	Theoretical	Furnished
of Pieces	D ft	Area ft²	D ft	Area ft²	Swing deg	Bend deg	Bend ø deg
12	5.09	21	6.27	31	30.0	20.0	30.0
14	5.94	28	7.31	42	25.7	15.7	25.0
16	6.79	36	8.36	55	22.5	12.5	20.0
18	7.64	46	9.40	69	20.0	10.0	20.0
20	8.49	57	10.45	86	18.0	8.0	15.0
22	9.34	69	11.49	104	16.4	6.4	15.0
24	10.19	82	12.53	123	15.0	5.0	15.0
26	11.03	96	13.58	145	13.8	3.6	10.0
28	11.88	111	14.62	168	12.9	2.9	10.0
30	12.73	127	15.67	193	12.0	2.0	10.0
32	13.58	145	16.71	219	11.3	1.3	10.0
34	14.43	164	17.76	248	10.6	.6	10.0
36	15.28	183	18.80	278	10.0	1	
38	16.13	204	19.85	309	9.5]	
40	16.98	226	20.89	343	9.0		
42	17.83	250	21.94	378	8.6 8.2	i	
44	18.67	274	22.98	415	8.2	1	
46	19.52	299	24.03	453	7.8 7.5	1	
48	20.37	326	25.07	494	7.2	1	
50 52	21.22 22.07	354 383	26.11 27.16	53 6 57 9	6.9		-
54	22.92	413	28.20	625	6.7		
56	23.77	444	29.25	672	6.4		
58	24.62	476	30.29	721	6.2		
60	25.46	509	31.34	771	6.0		
62	26.31	544	32.38	824	5.8		
64	27.16	580	33.43	878	5.6	1	
66	28.01	616	34.47	933	5.5		
68	28.86	654	35.52	999	5.3	1	
70	29.71	693	36.5 6	1050	5.1		
72	30.56	733	37.61	1111	5.0		
74	31.41	775	36.65	1173	4.9	•	
76	32.26	817	39.69	1238	4.7		
78	33.10	861	40.74	1304	4.6	1	
80	33.95	905	41.78	1371	4.5	İ	
82	34.80	951	42.83	1441	4.4		
84	35.65	998	43.87	1512	4.3	1	•
86	36.50	1046	44.92	1585	4.2]	
88	37.35	1096	45.96	1659 1736	4.1 4.0	1	
90 92	38.20	1146	47.01 48.05	1813	3.9	1	
92 94	39.05 39.89	1198 1250	49.10	1893	3.8	1	
94 96	39.89 40.74	1304	50.14	1975	3.8		
98	41.59	1359	51.18	2057	3.7	Ì	
100	42.44	1415	52.23	2143	3.6	1	
***	16.77			1 2170		<u> </u>	

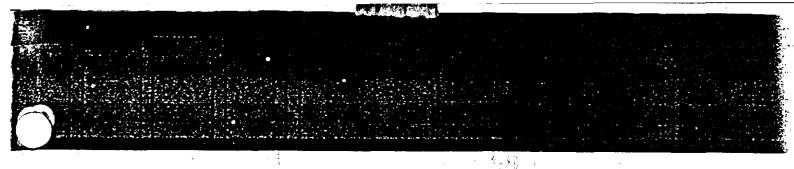
*PSA23, PS27.5 and PS31, when properly interlocked, are designed to provide a swing up to 10 degrees (in either direction) for lengths up to 70 ft. The ability to obtain a full 10 degree swing decreases with length because of the difficulty in handling the longer pieces. For lengths over 70 ft. it is necessary to anticipate a reduction in obtainable swing of 1.5 degrees for each 10 ft increase in length.





Small cells constructed with bent web piles must have half of the piles bent with fingers inside and half with fingers outside. For example, with Section PSA 23, half the piles would be BW230 and the remainder would be BW231. Refer to pages 26 and 27 for section data on bent web piles.

See page 24 for "Setting and Driving Tips," including guidance for template sizing.



Orders should specify if no holes are required.

All fabricated connections have handling holes that are 1-3/8 in. in diameter. They are located about 6 in. from the top of each leg.

Pairing

Z-Piling in lengths up to 60 ft can be supplied in pairs. The pairs will be shipped without welding or crimping which will insure maximum flexibility when setting a wall.

Driving

Assembly of panels of steel sheet piling before driving is suggested. This facilitates driving, maintains piling verticality, and makes it possible to obtain the nominal width of piling sections.

Z-piles should be driven with the ball edge leading. In addition, care should be taken — in the selection of connections and in planning for closed structures (cofferdams, etc.) — to provide for the proper sequence of driving. For normal interlocking, alternate Z-piles must be reversed end for end.

For setting and driving tips see page 6 for Z-piling and page 24 for PSA and PS piling.

Technical Information

Bethlehem is prepared to furnish additional technical information on sheet piling and its uses and will consult with engineers who are preparing designs that involve Bethlehem Steel Sheet Piling. Call your nearest Bethlehem representative or get in touch with Piling Products, Bethlehem Steel Corporation, Bethlehem, PA 18016.

Chemical Composition Percent (Heat Analysis)

Grade	Carbon Max	Man- ganese	Phos- phorus	Sulfur Max	Silicon Max	Vanadium	Copper Min	Nickel
A328	_		.04 max	.05		_	**	
A572-Gr 50	.23	1.35 max	.04 max	.05	.40	.01/.15*	**	
• Gr 60	.26	1.35 max	.04 max	.05	.40	.01/.15*	**	-
A690	.22	.60/.90	.08/15	.05	40		.50	.40/.75

^{*}In lieu of vanadium, 0.005/0.05% columbium may be used.

Mechanical Properties

Grade	Min Yield Point, Ksi	Min Tensile Strength, Ksi	Elongation in 8 in., min%
A328	39	70	17
A572-Gr 50	50	65	18
-Gr 60	60	75	16
A690	50	70	18

V-STAR 50* Impact Resisting Steel

Section	Charpy (CVN) Energy**
PZ22, PZ27	
PSA23	15 ft-lb @ -50F
PS27.5, PS31	
PZ35, PZ40	15 ft-lb @ 0F

^{*}Meets all the requirements of ASTM A572 -Grade 50

^{**}When copper-bearing steel is specified, the minimum copper is 0.20 percent.

^{**}Inquire about availability of other toughness requirements

General Specifications

Material

Bethlehem Steel Sheet Piling is furnished to the requirements of the Standard Specification for Steel Sheet Piling of the American Society for Testing and Materials, ASTM Designation A328. In addition, Bethlehem can supply sheet piling in high-strength, low-alloy grades - ASTM A572-Grades 50 and 60 and ASTM A690. Bethlehem can also supply sheet piling to meet Charpy (CVN) requirements. All grades of steel are readily available from regular mill rollings.

Number of Tests

Two tension tests shall be made from each heat. In addition, two interlock tests shall be made from each heat for sections PSA23, PS27.5 and PS31.

Tolerances

When using steel sheet piling, it is necessary to make allowances for deviations from theoretical exactness. The degree of precision obtainable in the production of steel sheet piling is limited by the basic character of the rolling processes and normal limitations of mill equipment. Interlocks should be continuous and reasonably free-sliding when threaded.

Care must be taken during installation to assure that each pair of sheets is being set at the desired driving dimension.

All steel sheet piling and fabricated connections have an allowable weight variation of $\pm 2 \cdot 1/2\%$ and are invoiced on theoretical weight. Length tolerance is -0 in., +5 in.

Fabricated Connections

Unless otherwise specified, all connections will be fabricated with angles or bent plates, with appropriate grades as necessary, and with high-strength bolts. ASTM A690 connections will be furnished with angles or plates made from ASTM A588 steel and with ASTM A325 Type 3 bolts. Lengths

Sheet piling sections are rolled and cut to the ordered length. For best economy, the designer should specify the actual length as calculated in the design process. An exception would be when many different lengths are required, such as in a sloped wall. Economy is best achieved in such cases by ordering in one-ft increments.

All sections are readily available in lengths up to 70 ft from regular rollings. Bethlehem can supply longer lengths, sometimes in excess of 100 ft, but requires sufficient lead time to properly schedule such material. Before ordering lengths exceeding 70 ft, it is best to check availability by calling the Bethlehem product office.

Splicing

If possible, splicing of Z-piling should be avoided. See page 6 for additional information.

Handling Holes

Unless otherwise specified, all plain piling sections shipped directly from the mill are provided with standard handling holes in the centerline of the web. The standard handling hole is a 2-9/16-in.-diameter hole approximately 6 in. from the end.

Z-Piling — one hole in each end.

PSA and PS Piling — one hole in one end only.

Bethlehem H-Piles

Bethlehem Steel pioneered the rolling of wide-flange shapes in 1908. Since then, one of these shapes—steel H-piles—has achieved wide application as foundation supports for bridges, piers, buildings, industrial plants, and other structures. H-piles possess the following advantages.

Great ability to stand up under hard driving.

□ Capacity to develop high bearing value when driven to rock, and as friction piles in suitable soils.

☐ High column strength.

☐ Low cost of driving.

☐ Small soil displacement, permitting close spacing where necessary.

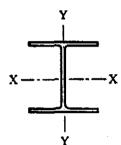
☐ Long life.

☐ Full-strength splicing easily attained.

H-Piles in Soldier Beam Construction

Steel H-piles are used extensively and advantageously in the construction of sheeted trenches for sewers, subways, and similar structures. They are driven in advance of the excavation, usually on 6- to 8-ft centers. As excavation proceeds, horizontal timber lagging is set in place between the pile flanges.

The trench is braced by means of cross-struts of steel framed against the inside flanges of the piles or into horizontal waling pieces. After the ench is completed, the piles are pulled and reused in the same manner. In addition to providing a "backbone" of steel for the trench lagging, piles used in this manner have the important advantage that they can be driven well in advance of the excavation. In city streets, the piles can be driven through small holes cut in the pavement. These holes can be filled after the piles are driven so that traffic may proceed until the excavation approaches.



Design Properties

	Weight	Area	Depth	Fla	nge	Web	Axis X-X Axis Y·Y					Surface Area	
Section Number	per	of Section	of Section	Width	Thick- ness	Thick- ness			•				
	lb	lb in.2		b _f t _f in.	t _w in.	l _x in.4	S _x in.3	r _x in.	ly in.	S _y in.	. r _y	ft²/ft	
HP14X	117	34.4	14.21	14.885	0.805	0.805	1220	172	5.96	443	59.5	3.59	7.11
	102	30.0	14.01	14.735	0.705	0.705	1050	150	5.92	380	51.4	3.56	7.06
	89	26.1	13.83	14.695	0.615	0.615	904	131	5.88	326	44.3	3.53	7.02
	73	21.4	13.61	14.585	0.505	0.505	729	107	5.84	261	35.8	3.49	6.96
HP12×	84	24.6	12.28	12.295	0.685	0.685	650	106	5.14	213	34.6	2.94	5.97
	74	21.8	12.13	12.215	0.610	0.605	569	93.8	5.11	186	30.4	2.92	5.91
	63	18.4	11.94	12.125	0.515	0.515	472	79.1	5.06	153	25.3	2.88	5.86
	53	15.5	11.78	12.045	0.435	0.435	393	66.8	5.03	127	21.1	2.86	5.82
P10×	57	16.8	9.99	10.225	0.565	0.565	294	58.8	4.18	101	19.7	2.45	4.91
1	42*	12.4	9.70	10.075	0.420	0.415	210	43.4	4.13	71.7	14.2	2.41	4.83
-AP8×	36*	10.6	8.02	8.155	0.445	0.445	119	29.8	3.36	40.3	9.88	1.95	3.92

^{*}Sections currently produced by Bethlehem Steel.

VENDOR INFORMATION

Vinyl Sheet Piling





Vinyl sheet piling solutions for marine applications



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Product Description

ShoreGuard patented interlocking vinyl sheet piling is clearly second to none when tested for long-term product performance. Its innovative design is fortified by co-extrusion – the industry-preferred manufacturing process. During the co-extrusion process, high-performance polymers are molecularly bonded to form a homogeneous part that guarantees strength, UV protection and color consistency. Combining an exceptionally high-quality virgin cap stock with an inner core or substrate that exceeds all specifications for quality, ShoreGuard sets the industry standard for all others to be compared against in terms of consistency, reliability and performance.

Features

- Co-extrusion process for long-term product performance
- I-Beam Lock™ for improved driving ability and strength
- Field proven engineering, thickness, geometry of locks and other design elements have been confirmed in the lab and in the field, to ensure no product failures
- Strong Back Ribs™ to provide commercial grade strength and higher impact drivability
- Patented design technologies we have developed and own the technology to guarantee a truly "value-engineered" solution

Advantages to You

- Increased profitability
- Reduced operational costs and safety risks
- Maximized product performance and durability
- Optimized construction processes to reduce installation time
- Guaranteed industry-specific expertise
- · Seamless environmental integration; creating no environmental hazard

Applications

- Seawalls
- Wavebreaks
- Bulkheads



Specifications

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Characteristic	Units	ShoreGuard 700	ShoreGuard 500	ShoreGuard 300	ShoreGuard 158
Long-Term Allowable Moment Rating	Foot-Pounds / Linear Foot	8,890	4,223	2,889	1,334
Factor of Safety for Greep	N/A	1.5	1.5	1.5	© 1.5
Factor of Safety for Durability & Construction	N/A	1.5	1.5	1.5	1.5
Fransmissivity	Centimeters / econd for SW Solis	4.15 x 10 ⁻⁶	2.7 x 10-6	2.7 x 10-6	2.5 x 10-4
Weight per foot of sheet piling	Pounds / Square Foot	. 8	5	3.2	2.6
Nominal Thickness	Inches	0.45	0.40	0.25	0.20
Linear Coverage	Inches	12	12	12	10.5
Depth of Section	Inches	10	8	7	5
Section Modulus Cubi	c Inches / Linear Foot	40	19	13	6
lensile Strength by ASTM D-638	Pounds / Square Inch	6,300	6,300	6,300	6,300
mpact Strength By ASTM 0-4226	Inch-Pounds / Square Inch	15,000	13,750	13,750	11,000
Modulus of Elasticity By ASTM 0-790	Pounds / Square Inch	380,000	380,000	380,000	380,000
I-Beam Lock™	N/A	Yes	Yes	Yes	Yes
Co-Extrusion	N/A	Yes	Yes	Yes	Yes
UV Protection	N/A	Yes	Yes	Yes	Yes
Strong Back Ribs™	N/A	Yes	Yes	Yes	Yes
		ShoreGuerd 700	ShoreGuerd 500	ShoreGuard 300	ShowQuard 150



4501 Circle 75 Parkway Suite E-5370 Atlanta, GA 30339 **800.256.8857** 770.933.8166 770.933.8363 fax www.materialsintl.com Physical properties are defined by ASTM Test Standards for Plastic Building Products. The values shown are nominal and may very. The information found within this prochure is believed to be true and accurate. No warranties of any kind are made as to the suitability of ShoreGuard for particular applications or the results obtained therefrom. ShoreGuard@ is a registered trademark of Materials International, Inc. United States Patent Numbers 5,145,287; 5,881,508; 29/085,704. Other patents pending. ©1999 Materials International, Inc. All Rights Reserved.

Color Palette

- Grey
- Green
- Beige
- Sandstone (textured)
- Brown

The key to ShoreGuard's success is the manufacturing process. Our specialized extrusion facility operates on the forefront of technology. State of the art equipment, skilled engineers and the finest raw materials ensure a superior product. Our zero-defect quality control program makes sure that our products perform in their critical functions.

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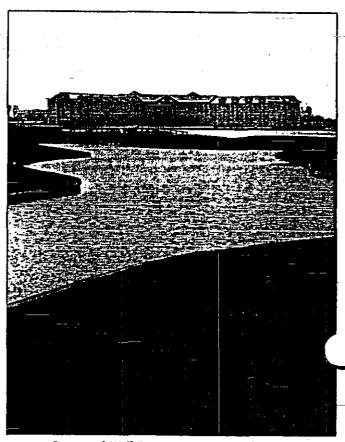
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SHOREGUARD ADDS BEAUTY AND VALUE

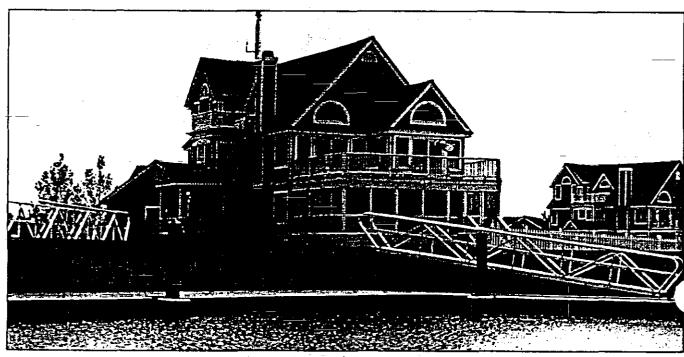
ShoreGuard is a patented interlocking sheet piling made of a high performance, rigid, weatherable polymer. ShoreGuard offers substantially longer service life because it will not rust, rot, corrode, be eaten by marine organisms, or be affected by the pH of the surrounding soil.



Aesthetic Enhancement of Shoreline



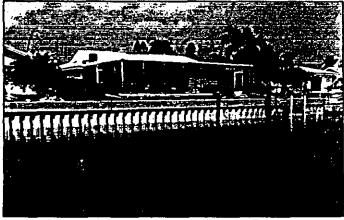
Contoured Wall Protects Fairways and Greens



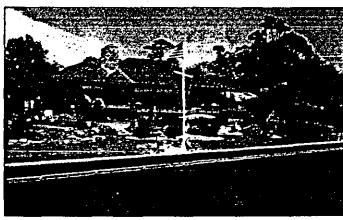
Waterfront Protection for Classic Homes

In Numerous Waterfront Designs

ShoreGuard, is used in numerous designs for a variety of waterfront projects. Seawall and bulkhead design and construction is a complex process with many variables, equations and procedures. This brochure does not address the hundreds of possible combinations of variables that come into play in a particular seawall application. It is intended as an aid to marine contractors and engineers in evaluating the suitability of ShoreGuard for their application.

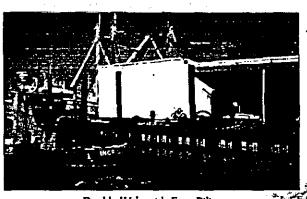


Concrete Cap

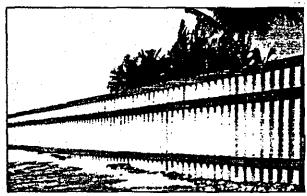


Dropped Single Wale





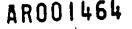
Double Wale with Face Piling



Triple Wale



Triple Wale with Face Piling

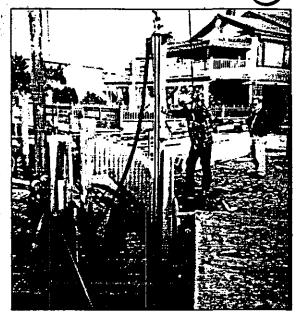


KNOW YOUR SITE CONDITIONS AND

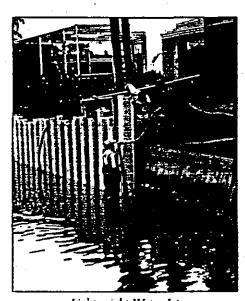
Seawalls and bulkheads are "soil driven", meaning that the site soil conditions will dictate the best design, materials, and construction methods. A thorough knowledge of site soil conditions is not only paramount in designing a proper structure, but in selecting the best installation tools. Consult your contractor and engineer for the appropriate design and construction method.

GRANULAR SOILS - SAND AND GRAVEL

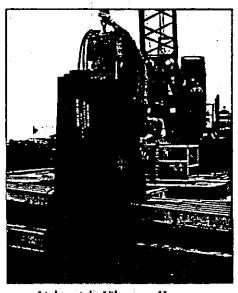
Water jets, rail jets, and vibratory hammers are used to install sheet piling where site construction consists of granular soils.



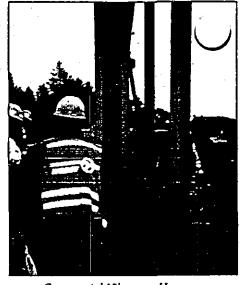
Heavy-Duty Rail Jet



Lightweight Water Jet



Lightweight Vibratory Hammer



Commercial Vibratory Hammer

CONTRACTOR TIP

"When driving into sand use a water jet or vibratory hammer. When driving into clay use a drop hammer or impact hammer."

Use the Best Installation Method

COHESIVE SOILS - CLAY

Drop hammers from 500 to 3500 pounds are selected based on site soil conditions and required embedment depths.



Drop Hammer



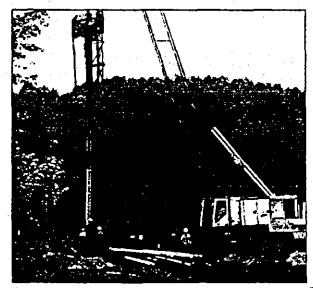
Drop Hammer with Water Jet

ORGANIC SOILS

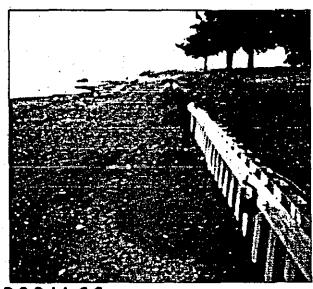
Certain soils around bayous, lagoons, and other areas contain peat or silt. These soils are traditionally very soft and provide little support which makes choosing equipment easy, but the working wall heights will be greater and longer sheets may be required.

EXTREME SOIL CONDITIONS - HARD CLAY AND SAND OR DEBRIS

In difficult site conditions, two methods are typically used. Contractors will "trench and fill" or utilize a steel mandrel.



Vibratory Hammer with Steel Mandrel



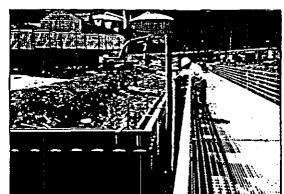
RO01466 Trench and Fill



ESTIMATE YOUR MATERIAL REQUIREMENTS

This is not a design chart. This is for estimating the material requirements for budgetary purposes. Please rely on your engineer for design plans. To assist in estimating your sheet pile requirements, follow these simple steps.

- 1. Measure the "linear footage" of the proposed bulkhead, including return walls.
- 2. Measure the "exposed height" of the proposed bulkhead. That is the measurement from firm soil at the base of the wall to the top cap. To find this firm ground and to properly measure the "exposure", you must probe the soil every 5 feet with a rod to ensure that the wall height is accurately measured including "valleys" or soft spots. If a valley is discovered, longer sheets are required, and if the valley is deep enough, additional support wales or heavier sheet piling may be needed.
- 3. To correctly estimate the number of sheets required, compute as follows:
 - ShoreGuard 150 (10.5 inches wide) Multiply the linear footage by 1.15 (example: 134 linear foot wall x 1.15 = 154.1 or 155 sheets)
 - ShoreGuard 300, 500 or 700 (12 inches wide) Number of sheets equals linear feet (example: 134 linear foot wall equals 134 sheets)
- 4. Remember to order corners! Remember, ShoreGuard 150/300/500 utilize a universal corner. (See page 9) ShoreGuard 700 uses a corner exclusive to the product. (See page 9)
- 5. It is recommended that contractors order extra corners to avoid running short and potentially holding up a project.

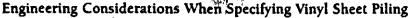


	1 July 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Typical Materi	ial Requir	ements f	or Single	e Wale W	alls		
Maximum Wall Height	Typical Sheet Length	ShoreGuard	Number of Wales	Outside Wale	Inside Wale	Tie Rod Length	Distance Between Rods	Number of Tie Rods per 100'	Sack Fill
3"	•	700, 500, 300, or 150	1 :	4" X 6"	2" X 6"	12"	5'	21	Sand / Gravel
4'	8"	700, 500, 300, or 150	1	4" X 6"	2" X 4"	12	5'	21	Sand / Gravel
5"	10"	700, 500, or 300	1	4" X 4"	2" X 6"	15'	5'	21	Sand / Gravel
° C	12"	700, 500, or 300	1	6" X 6"	2" X 6"	15'	5'	21	Sand / Gravet
7	14'	700 or 500	1	6" X 6"	2" X 6"	20"	5'	21	Sand / Gravel
· ·	16'	700	1	6" X 6"	2" X 6"	20"	\$'	21	Sand / Gravel

		Typical Material Requirements for Multiple Wale Walls								
Maximum Wall Height	Typical Sheet Longth	ShereGuard	Number of Wales	Outside Wale	Inside Wale	Tie Rod Length	Distance Between Rods	Number of Tie Rods per 100'	Back Fill	
\$	10"	700, 500, 300, or 150	2	4" X 6"	2" X 6"	15'	5'	42	Sand / Gravel	
r	12"	700, 500, 300, or 150	2	65 X 6"	2" X 6"	15"	5'	42	Sand / Gravel	
7	14"	700, 500, 300, or 150	2	6" X 6"	2" X 6"	20"	5'	42	Sand / Gravel	
*	16.	700, 500, or 300	2	6" X 6"	2" X 6"	29'	5'	42	Sand / Gravel	
8.	16"	700, 500, or 300	. 2	6" X 6"	4" X 6"	20"	5'	42 .	Sand / Gravel	
10'	20"	700, 500, or 300	2	6" X 8"	4" X 6"	20'	\$	42	Sand / Gravel	
11'	22	700 or 500	2	6", X 6"	4" X 6"	20	5'	42	Sand / Gravel	
12"	24'	700 or 500	. 2	6" X 8"	4" X 6"	20"	5'	42	Sand / Gravel	
13'	26	700 or 500	3	6. X 6.	4" X 6"	20"	5'	63	Sand / Gravel	
14'	26'.	700	3	6. X 8.	4" X 6"	201	5'	63	Sand / Gravel	
15'	30"	700	3	6" X 8"	4" X 6"	20'	5'	63	Sand / Gravel	



Engineering Considerations



Materials International is the largest manufacturer of vinyl sheet piling in the world. Ten years ago, we developed ShoreGuard, the first commercially successful vinyl sheet piling. Today we have millions of square feet installed worldwide. Materials International offers the widest selection of vinyl sheet piling in the industry. Whether you require the lightest vinyl sheet piling or the heaviest, or something in between, we not only make it, but offer it in a range of colors. Most importantly, we have developed a reliable method of determining long-term product performance by utilizing a combination of critical design elements. By optimizing these performance constraints and incorporating them into a design value known as the long term allowable moment, we provide simple, consistent, and reliable information for use in conventional design equations.

Long Term Allowable Moment

We incorporate the physical properties of Section Modulus and Web Geometry, the material properties of Tensile Strength and Long-Term Weatherability, with conservative Factors of Safety to determine the allowable moment of each of our sheet piling. Reported in foot-pounds per linear foot, long term allowable moment is the most descriptive value that exists for representing the long-term strength capabilities of vinyl sheet piling. We suggest using ShoreGuard's long term allowable moment rating as your principal design value when writing specifications or designing structures. Use ShoreGuard and know that the critical design elements are considered and optimized for long term performance. A word of caution ... it is easy to report a higher long term allowable moment when you eliminate or manipulate one or more design elements. We strongly recommend a thorough analysis when comparing products.

Tensile Strength

For vinyl sheet piling, the limiting factor in performance under load is a function of the tensile forces acting on the joutside flat portions of the sheet piling. Therefore, we design all of our sheet piling with the appropriate thickness in the flat sections to accommodate the long term loading requirements. Furthermore, we locate the interlocks, the area of greatest mass in our sheet piling, in the outer flat portions to further increase its strength.

Section Modulus

All of our sheet piling is designed to optimize the properties of vinyl through the shape or section modulus of the sheet piling by utilizing AutoCad Solid Modeling.

Web Geometry

Web geometry encompasses the ratio of wall thickness to cross section depth and the angle of the web. This geometry is critical in preventing the web section from yielding under load, known as web crippling. This failure will affect sheet piling where the wall thickness at the web section is too thin or the angle too steep in proportion to the cross section depth.

Long Term Weatherability

All of our sheet piling utilizes high performance (UV) stabilized virgin compound specifically designed for maximum outdoor weathering.

Factors of Safety

For reliable long term performance, we incorporate several safety factors into the allowable moment of our sheet piling. We not only account for variances in manufacturing tolerance and raw materials, we account for the effects of material creep failure. In addition, we apply a general factor of safety of 1.5 to insure that ShoreGuard performs for a lifetime.

If you have any questions or would like our report Engineering Considerations when Specifying Vinyl Sheet Piling, please call Materials International at (800) 256-8857 in the USA, or (770) 933-8166 for international calls.



KNOW YOUR VARIABLES!

IMPORTANT CONSIDERATION FOR ENGINEERS AND DESIGNERS OF SEAWALLS AND RETAINING WALLS: Designing with ShoreGuard is no different than designing with steel or wood. When developing a seawall, bulkhead or retaining wall design, ensure that the forces generated by the site conditions in your

design do not exceed the maximum allowable moment rating of the ShoreGuard product you specify.

SOME VARIABLES TO CONSIDER:

Below are a few site and design considerations that must be addressed for all seawall, bulkhead, or retaining walls.

- Soil type (sand, clay, organics, density, porosity)
- Sheet embedment depth
- Water currents, drainage, scour potential
- · Slope behind the wall
- Additional loading factors on wall (buildings, roadways, vehicles, boatlifts, etc.)
- Silt and muck deposits at toe (base) of wall
- Installation equipment (see "Know Your Site Conditions and Use the Best Installation Method"... pg.3)

FOUR PROBLEMS ... THE EFFECTS AND THEIR CAUSES

ONUJE					
Insdequate embedment	X				
Poor backfill	X X X				
Sheet not driven into firm bottom soil (muck tayer)	xx	1			()
Unusual scour at toe of well (base)	\ \ \ x \ x				
Steep stope or berm behind wall adds loading	X X X X				
Building or structure close to wall (surcharge loading)	X X X	×			
Rapid water drawdown (wind, tide, hurricane)	\				
Walf too high without adequate support (wales, piles, both)	_ \				
Insufficient granular backfill in wedge behind wall	\	$\overline{}$			
Tie rods too small (diameter)	X		_		
Anchors (deadmen) too small (surface area of anchor is the key)	X X		\supset		
Anchors too close to wait	xx				
Dimension of wales too small	\	x \			
insufficient number of tie roda (distance between)	X X	x			
Driving guide not used during installation	X				
Lack of fasteners when attaching sheets to wales	X \	X	\	_	
Lack of back wale (front wale only) or sheets not bolted to back wale	x			\supset	
Unusual dramage conditions (pooling) behind walf		x \ x	x	_	
2 - 2 - 4 - MCOR	EFFECT WARE	ART TO SE	MAIL SELLING	RACE OF SHEET	THORIES.
- 	Backward rotation of wale / wall	×		X	X
- 	Extreme backfill settlement / loss of fill	1		X	×
<u> </u>	Backfill appears at front toe of wall	 	<u> </u>		X
المستنسبة المستنسبة المستنسبة	Sinkhole develops behind wall	 		×	×
2 - Hareland	Noticeable "bellying" at middle of wall	 	 	x	
and the second s	Forward rotation of wale / wall	×	×		
	Wate curves outward between his rods	 	 	 	\vdash
Seawall engineering is a complex	Train our res comment desmants de loca		 	 	
	Sheet loses corrugation (flattens)	1	l x	! X	

Please Note: This chart is not inclusive of all the site conditions and influences that may exist in your area. However, it will give you few to consider before you begin. These problems, causes and effects are the usual consequences of improper design and construction no matter what material is used for sheeting.



INSTALLATION ADVICE FROM CONTRACTORS

No two seawalls are the same. The numerous job site variables make it impossible to provide specific construction designs without careful analysis of each variable and the effect it will have on the structure. That analysis should be left up to a professional marine contractor or engineer.

The following is a step by step installation procedure taken from years of contractor field experience with ShoreGuard. These installation tips should prove helpful to you as you prepare your plans.

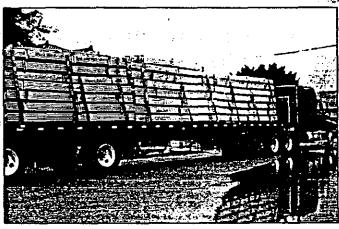


Fork truck unloading 2,000 lb. bundles of ShoreGuard

STEP 1. MATERIAL HANDLING

While ShoreGuard is relatively lightweight, you will still need appropriate material handling equipment to unload and stage the materials on your site.

All orders are F.O.B. our factory in Georgia. This means the purchaser is responsible for receiving and inspecting the materials upon arrival, documenting any damage or shortage, and filing any freight claims with the trucking company. Please be sure to document any in-transit product damage or receiving discrepancies on the bill of lading and have the driver sign it.



Full truckload of ShoreGuard arrives on site

STEP 2. SET DRIVING GUIDE



Use either the front or back wale at the top of the wall to act as a structural driving guide to ensure that the sheet piling drives straight. Do not attempt to use a stringline as a driving guide. It will not offer any corrective support if the sheet piling tries to wander out of plumb.

- a. Drive wooden posts or piling at appropriate intervals to support the top wale in its intended final position.
- b. Tack nail the top wale to the temporary posts or piling. It is often helpful to nail a second, temporary "kickboard" to help with sheeting alignment.

CONTRACTOR TIP

"A driving guide saves time and helps keep the wall straight."

INSTALLATION ADVICE

STEP 3. DRIVE FIRST PAIR OF SHEETS



- a. Thread two sheets together. Place the "outer flat" section against the driving guide and drive the sheets to grade. Use a level to ensure that the sheets are plumb.
- b. After driving sheets to grade, use lag screws (supplied in hardware package) to lag flat of leading sheet to the wale.
- c. (Hint): For ShoreGuard 150, make sure that each pair covers 21" (24" for ShoreGuard 300/500/700).
- d. (Hint): Lead with the male lock so that the female lock of each new pair is driven over the male of the last driven pair.

STEP 4. INSTALL REMAINING SHEETS



- a. Once the first 2 sheets have been sheets are driven and lagged to wale.
- b. Continue to check for alignment with a level as you drive sheets.

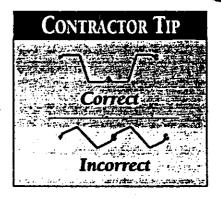
aligned and lagged, thread the next pair onto the lock and drive to grade. Lag "flat section" to wale, check alignment and repeat process until all

STEP 5. INSTALL CORNERS



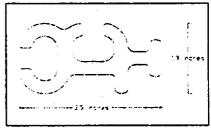
- a. The Corner Pieces are inserted in the lock and driven to grade. Place the front flat section against the driving guide and drive the sheets to grade.
- b. Important: Wing walls must be tied back to anchors, and corners braced. Scouring and erosion are more likely at corners since the currents tend to swirl in this area.

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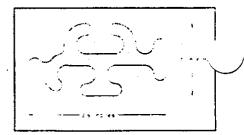


CONTRACTOR TIPS

Lead with the male to keep the locks from fillin with soil, which slows you down Lag as you go to keep the wall straight and avoid over-Drive in pairs for speed and



ShoreGuard 700 Corner



ShoreGuard 150/300/500 Corner

FROM CONTRACTORS

STEP 6. FASTEN INSIDE WALE TO SHEETS



- a. After all sheets have been driven and lagged to front wale, position the back wale and bolt wale to sheets.
- b. Next, drill and install through-bolts between the tie rods to bolt the front and back wale together. This will "sandwich" the ShoreGuard and create a single structure rather than a series of single sheets.

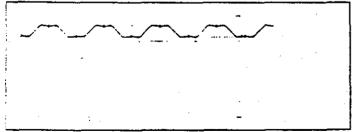
STEP 7. PLACE ANCHORS AND CONNECT TIE RODS

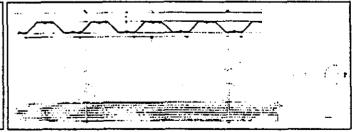


- a. Once again, there are many types of anchors. The engineer should consider which is best for the soils and topography.
- b. Placement of anchors is most important. They must be positioned in non-active soils. Drill holes through front and back wales and insert tip of tie rod, placing nut and washer on outside. Then drill hole into anchor pile, inserting other end of tie rod with nut and washer. Tighten each nut until wall is perfectly straight. "Ogee" washers are often used.

Typical Anchor Designs

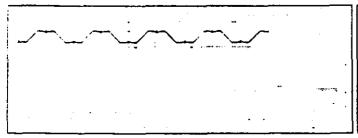
The stability of a seawall depends primarily on the stability of the anchor system. Here are a few of the most popular anchor systems used today.

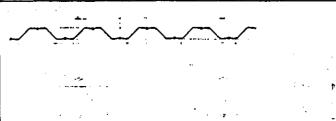




Vertical Treated Piling

Batten & Drag Piling





Individual Concrete Anchors



INSTALLATION ADVICE

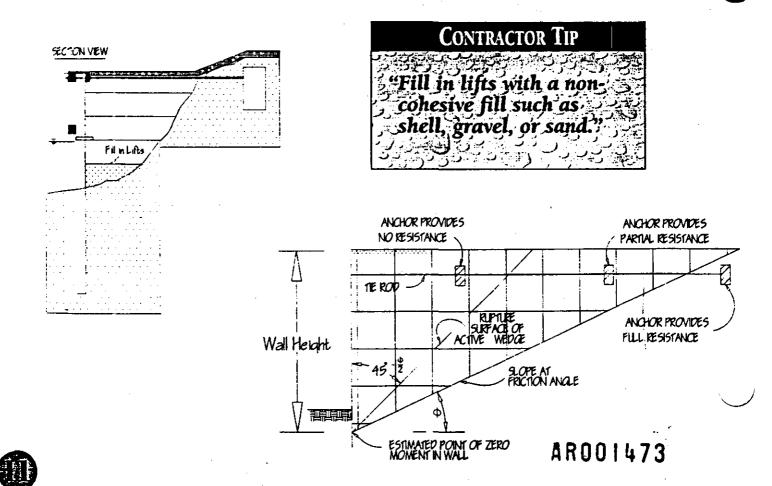
STEP 8. BACKFILL WITH GRANULAR MATERIAL



- a. Your choice in backfill influences your wall structure more than any other single factor. Use granular, free draining backfill. Contractors refer to it as "cheap insurance" against future problems.
- b. Backfill in "lifts" or layers, compacting each as you go. Some contractors will "wash" the sand down behind the wall. This is not only easy but compacts the sand too.
- c. (Hint) Weep holes are often installed, prior to backfilling, to provide additional drainage.

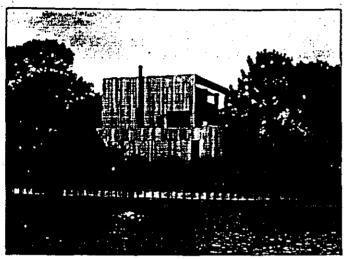
BACKFILL MATERIAL

The type of backfill is the single most important variable to be considered during the construction of a bulkhead. The soils dictate the amount of force acting on the wall. The soil must be free draining fill (sand, gravel, shell) compacted in layers or "lifts." Anchors need to be placed well back, outside the "active wedge" of unstable soils

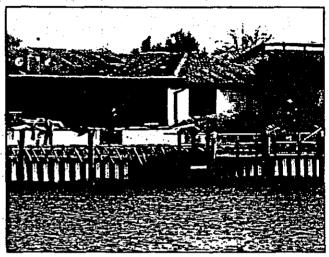


FROM CONTRACTORS

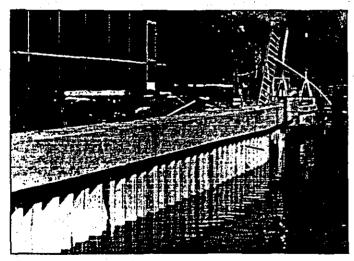
STEP 9. INSTALLATION OF WALL CAP



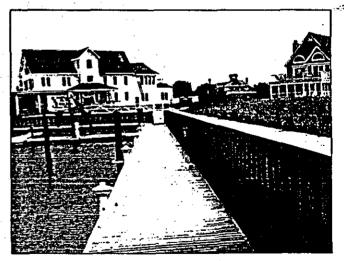
Wood Cap



Concrete Cap



Concrete Cap



Wood Cap with Deck

WOOD AND CONCRETE CAPS

Wood and concrete caps are the two most common ways to finish off your seawall or bulkhead. You can install simple caps made of pressure treated wood or incorporate elaborate wood docks and boardwalks. Concrete caps are also very popular, and are often used in areas prone to rough waters due to their strength and durability. Consult your contractor or engineer for the best option for your application.

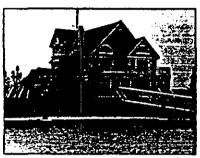
MATERIALS INTERNATIONAL, INC.



Materials International, Inc.'s mission is to revolutionize the industries we serve. Only ten years after the introduction of ShoreGuard, we have become the largest manufacturer of vinyl sheet piling in the world, supplying millions of square feet to the marine and industrial sheet piling industries. We believe that success is based on two elements, great people and innovative products. Our results oriented team members strive to improve every aspect of our business in the pursuit of excellence.



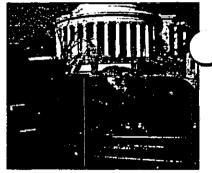
Our patented ShoreGuard is in great demand because it is easy to install, long lasting, and is environmentally safe. From canal side summer homes to commercial marinas, seawalls constructed with ShoreGuard are the market favorite.



Cape May Harbor Yacht Club



When corrosion resistant sheet piling is required, our patented GeoGuard is the best choice. GeoGuard has many geotechnical applications such as cut off walls, dams, levees, dikes, weirs, and other water control structures. GeoGuard has been specified and chosen as the erosion control sheet piling for The Army Corps of Engineers, Department of Transportation, Environmental Protection Agency, Department of Environmental Protection, State and Local Governments, and commercial and industrial clients.



Jefferson Memorial Rehabilitation



Our patented Lockfast vinyl decking is an easy to install alternative to traditional wood decking. Lockfast has several applications including docks, decks, porches, verandas, and piers. It is resistant to heat, salt water decay, warping, splintering, rust, marine organisms and termites. Lockfast is virtually maintenance free. It does not require any chemical preservatives and only occasional cleaning. Lockfast will provide years of enjoyment and added value to your home.



Materials International, Inc.

4501 Circle 75 Parkway • Atlanta, GA 30339 U.S.A. 800.256.8857 • ph. 770.933.8166 • fax 770.933.8363 Website: www.materialsintl.com



SHOREGUARD LIMITED WARRANTY

Materials International warrants that ShoreGuard meets the published physical properties as listed below, and further warrants against manufacturing defects that result in rot, decay, marine borer, or termite damage. Such warranty extends only to the original consumer, and is pro-rated for a period of fifty (50) years from the date of original purchase.

Specifications

The state of the s		The state of the s		•	
Characteristic	Units	ShoreGuard 700	ShoreGuard 500	ShoreGuard 300	ShoreGuard 150
Color	Light Grey, Beige, Dark Brown, Light Green	All Colors Available	All Colors Available	All Colors Available	All Colors Available
Transmissivity	cm/sec for SW soils	4.15 x 10 ⁻⁴ ··	2.7 x 10⁴	2.7 x 10 ⁻⁴	2.5 x 10 ⁻⁴
I-Beam Lock	N/A	Yes	Yes	Yes	Yes
Long Term Allowable Moment	ft-lb/ft	8,890	4,223	2,889	1,334
Nominal Sheet Piling Thickness	in	0.45	0.40	0.25	0.20
Weight per sq. ft. of Sheet Piling	lb/ft²	8	5	3.2	2.6
Linear Coverage per Sheet Piling	in	12	12	12	10.5
Depth of Section	1. In 1.	10	8	7.3	5
Section Modulus	in¹/ft	40	19	13	6
Tensile Strength by ASTM D-638	psi	6,300	6,300	6,300	6,300
Impact Strength by ASTM D-4226	in-lb/in²	15,000	13.750	13,750	11,000
Modulus of Elasticity by ASTM D-790	psi	380,000	380,000	380,000	380,000
Factor of Safety for Creep	N/A	1.5	1.5	1.5	1.5
Factor of Safety for Durability and Construction	N/A	1.5	1.5	1.5	1.5

Physical properties are defined by ASTM Test Standards for Plastic Building Products. The values shown are nominal and may vary.

Each ShoreGuard purchaser is solely responsible for determining the effectiveness, suitability, and safety of any particular use or application of the product. Materials International does not warrant any designs or engineering of specific structures utilizing ShoreGuard. Materials International does not warrant any components, other than ShoreGuard, used in any particular application. Materials International does not warrant any aspect of installation or workmanship of an installation.

Failure, damage, or malfunction resulting from misuse, abuse, negligence, alteration, accident, excessive loads, normal wear and tear, modification of the product, lack of proper maintenance, impact of foreign objects, tornado, hurricane, flood, fire, or acts of God shall not be considered as resulting from defects under this warranty.

Materials International's liability under this warranty is limited solely and exclusively, at our discretion, to replacement of defective ShoreGuard, pro-rated from date of purchase; or a refund of the original purchase price of the defective material, prorated from the date of purchase. In no event shall Materials International be liable for labor, installation, reinstallation, accessory materials, engineering, freight, taxes, or any other charges not directly related to defective product.

Original purchaser must give notice of any defect within five (5) days of discovery and include proof of purchase, photograph of defect, and written description of defect. Warranty claims should be directed to:

Materials International / 4501 Circle 75 Parkway, Suite E-5370 / Atlanta, GA 30339 Attn: Warranty

This warranty may not be amended except in writing and signed by an officer of Materials International and the purchaser. No person or entity is authorized by Materials International to make statements or representations regarding the performance of ShoreGuard products except as contained in this warranty, and Materials International shall not be bound by any such statements other than those contained herein.

The foregoing warranty is exclusive and in lieu of any and all other warranties, express or implied, including without limitation, any implied warranty of merchantability or fitness for a particular purpose, except with respect to the replacement of defective product as described herein, manufacturer shall not be liable for any direct or indirect, incidental, punitive, consequential, exemplary or other damages of any kind whatsoever related to the ShoreGuard product, whether such claim is based upon theories of contract, warranty, negligence, tort, strict liability or otherwise.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state. This agreement shall be governed by and construed in accordance with the laws of the State of Georgia.

SHOREGUARD SHEET PILING SPECIFICATIONS

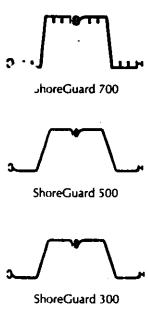
1.1 Acceptable Manufacturer

ShoreGuardo manufactured by Materials International, Inc., 4501 Circle 75 Pkwy, Suite E-5370, Atlanta, GA 30339, USA (800) 256-8857, Phone (770) 933-8166, Fax (770) 933-8363

Website: www.materialsintl.com

1.2 MATERIAL

Vinyl sheet piling shall be ShoreGuard ______ as manufactured by Materials International, Inc. or approved equal. The term equal shall be defined as meeting or exceeding each physical property requirement listed below. Alternate vinyl sheet piling products must have 10 days prior approval from the project engineer. The allowable moment must be calculated using industry accepted standard formulas (See ENGINEERING CONSIDERATIONS, SPECIFYING VINYL SHEET PILING, by Materials International, Inc.) where creep reduced allowable tensile strength of 2,667 psi. is utilized. The material manufacturer must have a minimum experience level of no less than 10,000,000 square feet of vinyl sheet piling in service.



ShoreGu	ard 150

Specifications								
Characteristic	Units	ShoreGuard 700	ShoreGuard 500	ShoreGuard 300	ShareGuard 150			
Color	Light Grey, Beige, Dark Brown, Light Green	All Colors Available	All Colors Available	All Colors Available	All Color Available			
Transmissivity	cm/sec for SW soils	4.15 x 10 5	. 2.7 x 10 ⁻⁴	2.7 x 104	2.5 x 10			
I-Beam Lock	N/A	Yes	Yes	Yes	Yes			
Long Term Allowable Moment	ft-lb/ft	8,890	4,223	2,889	1,334			
Nominal Sheet Piling Thickness	in	0.45	0.40	0.25	0.20			
Weight per sq. ft. of Sheet Piling	lb/ft²	8	5	3.2	2.6			
Linear Coverage per Sheet Piling	in	12	12	12	10.5			
Depth of Section	in	10	8	7	5			
Section Modulus	in³/ft	40	19	13	6			
Tensile Strength by ASTM 0-638	psi	6,300	6,300	6,300	6,300			
Impact Strength by 15TM D-1226	in-lb/in²	15,000	13,750	13,750	11,000			
Modulus of Elasticity by ASTM D-790	psi	380,000	380,000	380,000	380,000			
Factor of Safety for Creep	N/A	1.5	1.5	1.5	1.5			
Factor of Safety for Durability and Construction	N/A	1.5	1.5	1.5	1.5			

Physical properties are defined by ASTM Test Standards for Plastic Building Products. The values shown are nominal and may vary.

The information found within this brochure is believed to be true and accurate. No warranties of any kind are made as to the suitability of ShoreGuard for particular applications or the results obtained therefrom.

ShoreGuard and GeoGuard are registered trademarks of Materials International, Inc. ◆ Lockfast™ is a trademark of Materials Internationals, Inc. United Scates Patent Numbers 3.145,287; 5.881,508: 29/085.704 Other patents pending. ◆1998 Materials International, Inc. All Rights Reserved

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APPENDIX 6

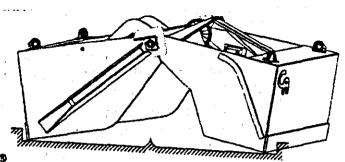
Dredging Equipment Information

ENVIRONMENTAL DREDGING GUIDE

1. GENERAL CHARACTERISTICS

Description:

- a) Mechanical Clamshell Bucket
- b) Rectangular footprint
- c) Operates on standard crane (cable)
- d) Horizontal closing action level cut CA®
- e) Overlapping side seals



CABLE ARM CLAMSHELL® BUCKET

Special Environmental Characteristics:

The large footprint and level cut closing action produces a level bottom profile. The level cut has a horizontal cutline accuracy of 10 centimeters.

Venting design system allows water to pass through opened bucket during descent creating minimum downward water pressure, therby minimizing sediment resuspension.

Regulated controlled closing system creates minimum disturbance of material inside clamshell and surrounding sediment.

Clamshell bucket is positioned (XYZ) using instrumentation.

The clamshell bucket design and operation accommodates onboard instrumentation.

2. ENVIRONMENTAL DATA

Parameters	Comments
Turbidty generation (mg/l)	By following defined procedures (relevant to site conditions) the Clamshell bucket can meet water quality standards (ie. TSS < 30% above background. Environment Canada Protection Services criteria.)
Accuracy	Vertical (Z) - 5 centimeters Horizontal (XY) - 10 centimeters
In situ density	> 60% () () () () () () () () () (
Spillage	none - lifting not intiated unless "close sensor" confirms complete seal
Noise	not above standard crane noise
Control of layer thickness	level cut action of Cable Arm Clamshell permits a uniform layer removal. Onboard instrumentation controls penetration depth.
Protection of crew	Clamshell bucket is a closed system when it leaves water column. Discharge and wash procedures ensures safety of crew
Mixture of layers	The XYZ positioning system can dependably position the clamshell cut line within centimeters of target depth.

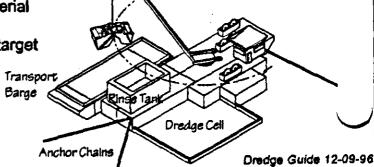
Dredge Guide 12-09-96

Low Turbidity Dredging Procedure using Cable Arm Clamshell® Environmental Overlapping Side Seal Bucket

Procedure CA.02.LT

Revised Date 12-01 1

- 1.0 Fully open bucket (bucket open light "on"
- 2.0 Position bucket (XY target)
- 3.0 Lower bucket at speed not to exceed 1 ft/sec
- 4.0 Stop bucket 6 ft from bottom (instrumentation "penetration depth" display)
- 5.0 Pause for 60 seconds (or until depth sensors digital display stabilizes)
 - 5.1 (Optional) Scan bottom profile by moving bucket over pre and post dredging target area to confirm "level out"
- 6.0 Lower to "target" penetration depth
 - 6.1 use instrumentation depth control display
 - 6.2 Lowering depth not to exceed final depth criteria (instrumentation "maximum depth" display)
- 7.0 Stop
- 8:0 Close bucket until side overlap seal light "on" (if light fails to go "on" follow procedure as defined in Project Contingency Plan "Bucket Seal Problem")
- 9.0 Stop
- 10.0 Lift bucket 6 feet from bottom
- 11.0 Slowly move submerged closed bucket toward receiving scow/container area
- 12.0 Slowly lift bucket to surface
- 13.0 Stop lifting when vents are visible (just above water line)
- 14.0 Let water drain from vents (until no visible flow)
- 15.0 Lift from water
- 16.0 Position over receiving container
- 17.0 Lower closed bucket into receiving container
- 18.0 Partially open bucket
- 19.0 Fully open bucket to discharge all material
- 20.0 Turn bucket vibrators "on" for minimum of 60 seconds (until all material is dislodged)
- 21.0 Turn vibrators "off"
- 22.0 Lift bucket above receiving container
- 23.0 Close bucket (seal light "on")
- 24.0 Move bucket over rinse tank
- 25.0 Fully open bucket
- 26.0 Lower bucket in rinse tank (submerge)
- 27.0 Turn vibrators "on" for minimum of 60 seconds
- 28.0 Move submerged bucket (tank size permitting) to create turbulence
- 29.0 Turn vibrators "off"
- 30.0 Lift opened bucket above rinse tank
- 31.0 Inspect bucket surfaces for adhering material
- 32.0 Repeat rinse cycle if necessary
- 33.0 Move fully opened rinsed bucket to next target



Cable Arm Inc.

ENVIRONMENTAL DREDGING

TURBIDITY CONTROL

Operating Procedure: Suspended Solids Monitoring

References:

Manufacturer's Manual ___

mananan di

A. Routine Daily Activities

The following activities should take place before dredging starts each day or if dredging has been suspended during the day for any reason.

- 1. Ensure computer recording system is switched on and operating manually
- 2. Suspended Solids Background Determination

The level of background total suspended solids (TSS) in the water column XX meters downstream from the dredging site will have to be determined before dredging starts, so that the appropriate alert level can be set. It will be assumed that any increase above the background is due to the dredging operation until an updated background can be made.

The instrument readings will be observed for a period of three minutes for each sensor and the average readings determined. The higher of the average readings will be considered the background and recorded. The alert alarm setting will be input at XXX mg/l above the background.

The following actions should be performed daily, but can be done at any time during the day.

3. Cleaning of Suspended Solids Sensors

The sensor has an infra red lamp in the cut out just above the end of the stainless steel sensor. The surfaces must be cleaned daily with a soft clean cloth to ensure that there is no reduction in transmission. This will involve raising the sensor out of the water. Only one sensor may be removed from service at a time.

Cleaning the sensor may show a step change down in the readings due to greater transmission. The size of the step should be noted and the alarm levels adjusted to account for the change. This is not a full background calibration, it merely adjusts the previous background calibration.

4. Calibration of Suspended Solids Sensors

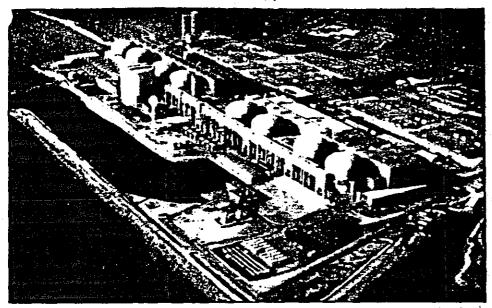
Once the sensor has been cleaned, a calibration check will be made. This will involve shaking up the calibration container which contains a known amount of solid material (site sediment sample) to ensure the solids are fully suspended. The reading of the sensor will be recorded and compared with the standard to determine whether recalibration of the instrument is required. An accuracy of +/- XXX mg/l will be acceptable. There will be at least two standards available.

Note: The project supervisor should be informed that the Alert or Shutdown Dredging alarms may be triggered during the calibration as one of the standards os likely to be above the normal background.

If recalibration is required, the details must be logged and the manufacturer's procedures followed.

Ontario Hydro Safely Dredges Cooling Water Intake at Nuclear Plant

By Deborah Hempel, P.E.



Overview of the Pickering Nuclear Generating Plant shows the channels where cooling water is drawn from Lake Ontario. The dredging was performed 50 feet from the screenhouse wall in the cooling water intake channel.

In May of 1993, Ontario Hydro, Pickering Nuclear Generating Station, used a Cable Arm Environmental Clamshell to dredge within their cooling water intake channel. The ickering plant is 30 kilometers east of Toronto, and is one of the world's largest nuclear plants, with a capacity of 4300 MW.

The objective of the project was to remove sediment within the station's cooling water intake channel approximately 50 feet south of the screenhouse wall. The dredging operations were not to adversely impact upon station operations with respect to reactor safety and system performance, and had to achieve compliance with environmental regulations. The dredging project using the Cable Arm Environmental Clamshell was a success. There were no noticeable effects on the cooling water quality, thus no effect on station operations or reactor safety. Potential effects resulting from increased sediment loading in the cooling water would have had substantial financial impacts due to potential unit de-rating or unit outages.

Since commissioning, Pickering Muclear Generating Station has experienced sediment entrainment problems within the cooling water intake channel, resulting in frequent unit de-rating. Problems have included the plugging of the service water strainers, heat exchanger piping corrosion, equipment replacement and increased maintenance. A solution to the station's sedimentation problems was to install a precast needed and fiberglass sediment bypass system within the cooling water intake channel in front



The custom-designed four-cubic-yard Environmental Bucket was able to remove the sedimentation and debris with a minimum of turbidity.

of the screenhouse in 1990. Conditional approval was granted for the operation of this system in 1992, subject to the removal of sediment which had accumulated on top of the 60-foot-diameter precast concrete intake structure.

Conventional dredging methods were investigated with respect to the station's operational requirements, which required that there be minimal sediment resuspension during dredging operations. The dredging would have to be carried out with four units at full power and at maximum intake flow rates.

Both conventional hydraulic and mechanical dredging methods were considered as not meeting the requirements of this dredging project. The conventional mechanical dredging method would have had a considerable amount

of sediment resuspension, thus adversely affecting station operations. The dewatering and disposal of the dredged material posed several operational as well as environmental problems. The conventional hydraulic dredging realso had problems associated with the comment and treatment of the discharge water during dredging operations. Again, the same sediment dewatering and containment problem also arose.

In 1992, Ontario Hydro undertook a search for innovative dredging technologies which would meet all the operational and environmental requirements. The dredging technology selected was the Cable Arm Environmental Clamshell. At the time, this technology was being demonstrated and tested by Environment Canada under the Contaminated Sediment Removal Program. (See IDR, June/July 1992, "Environment Canada Tests Cable Arm Bucket On Contaminated Sediment in Toronto.")

The Environmental Clamshell is a unique closed clamshell design which has been successfully proven to have minimal impact on the surrounding ecosystem. The level cut feature is one of the major keys to its success, enabling the removal of a specified layer thickness with minimum sediment resuspension, thus minimizing the possibility of recontamination or contamination of sediment during dredging.

The clamshell design features moveable top plates/vents which allow water to pass through as it submerges. There are less downward forces exerted throughout the water umn as the opened clamshell is lowered.\ resulting in minimal turbulence. During ascent the rubber side seals ensure that no additional water is mixed with the payload, thereby minimizing the mixing process and thus reducing the water content of the dredged material inside the clamshell. When the clamshell reaches the water surface, the ambient water is allowed to exit via air-operated vents. Screens are placed in front of the vents to trap any fines. Once the ambient water rupoff process is complete, the clamshell is hoisted to the appropriate disposal containment or holding facility. (See schematic in ad on page 2 of this issue.)

A public tender was called in Spring of 1993 to undertake the dredging of the funnel within the cooling water intake channel at Pickering NGS. The response from the local dredging industry was favorable towards the use of the Cable Arm Environmental Clamshell. No changes to a standard dredging plant setup were required, except that crane operator training was necessary. The contract to remove approximately 250 cubic yards without affecting station operations was awarded to Canadian Dredge and Dock Inc.

The four-cubic-yard clamshell was custom-designed to meet the project requents. The approximate weight of the buwas 6500 pounds, which was capable of an eight

ENVIRONMENTAL CLAMSHELL - SEDIMENT DREDGING

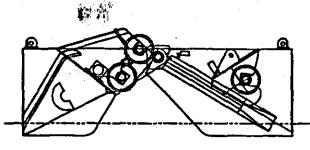
CAUSES OF TURBIDITY CONVENTIONAL CLAMSHELL

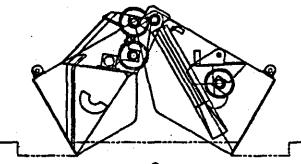
- Overfilling
- Downward Movement
- High Suction Digging Action
- Adhering Material
- Faulty Seals

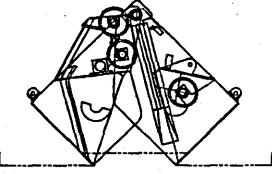
CABLE ARM FEATURES

- Volume Control (Electronic for Sediment-Water Interface)
- Passive Venting
- Horizontal Level Cut Closing
- Seal Alarm
- Dumping Vibrators
- Cleaning Vibrators Wash Tank
- Reeving Design
- Fail Safe Lock
- Low Suction Digging Action

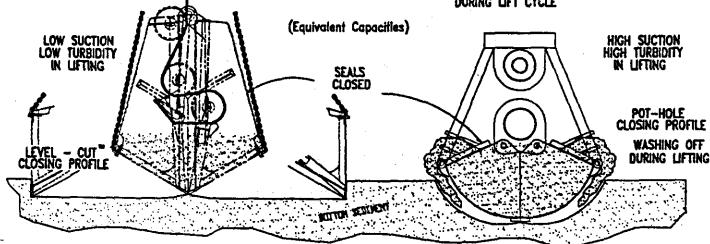
THE CABLE ARM CLAMSHELL DRAINS WATER ABOVE SEDIMENT—WATER INTERFACE AT THE SURFACE







THE CONVENTIONAL CLAMSHELL ALLOWS OVERFILL SEDIMENT AND OUTER BUCKET SHELL SEDIMENT TO BE DEPOSITED IN THE POTHOLE PROFILE DURING LIFT CYCLE

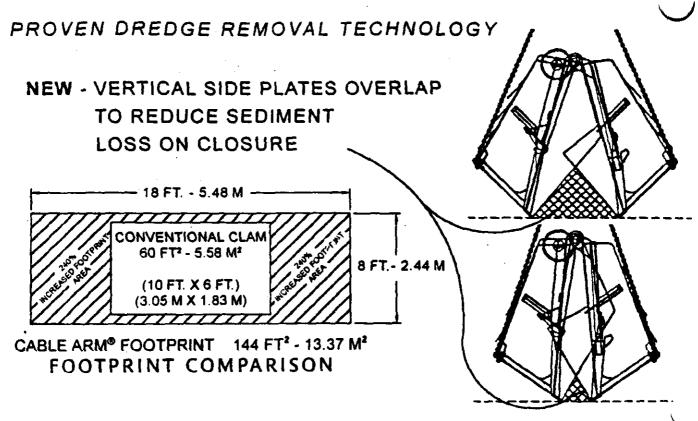


-452 W. JEFFERSON AVE. TRENTON, MICHIGAN U.S.A. 48183 - 2939 CABLE ARM CLAMSHELL

RAY BERGERON PH (#15) 876-6108 FAX (#18) 676-1345

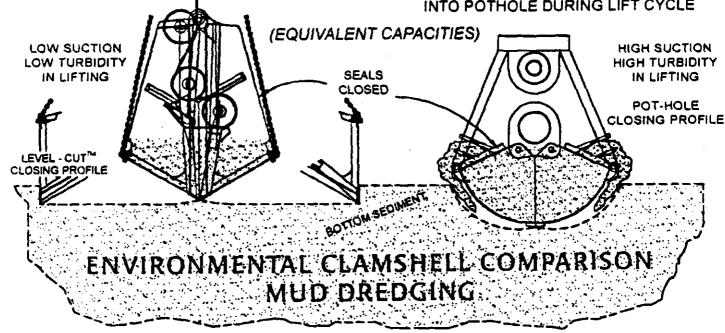
WHY STIR UP THE MUD?

DO IT RIGHT THE FIRST TIME. SPECIFY CABLE ARM® CLAMSHELL!



THE CABLE ARM® CLAMSHELL DRAINS
WATER ABOVE SEDIMENT-WATER INTERFACE

CONVENTIONAL CLAMSHELL REDEPOSTS
OVERFILL AND OUTER BUCKET SEDIMENT
INTO POTHOLE DURING LIFT CYCLE



+ CABLE ARM® CLAMSHELL AROU1485

SCR96

LOWER YOUR SEDIMENT TREATMENT COST!!



OVERLAPPING SIDEPLATES



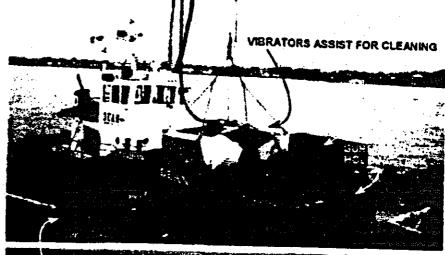
CONTRACTOR: DEAN CONSTRUCTION CO. TECUMSEH, ONTARIO.

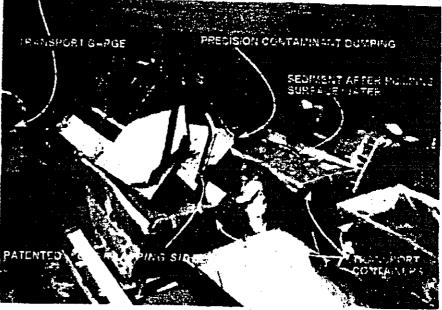
MONITORING BY: MOEE, ENVIRONMENT CANADA

"SATELLITE POSITIONING SYSTEM"

HIGHLIGHTS

-SIDE PLATES OVERLAP TO REDUCE
SEDIMENT LOSS ON CLOSURE
-DRAINS WATER FROM ABOVE SEDIMENT
-LOW SUCTION/LOW TURBIDITY IN LIFTING
WATER INTERFACE AT SURFACE
-HIGH SOLIDS TO LIQUIDS RATIO
IN SHALLOW SEDIMENT REMOVAL
-SAFETY (SEDIMENT CONTAINMENT)
-PRECISION (EXACT XYZ PLACEMENT)





CONTAMINATED SEDIMENT REMOVAL DOW CHEMICAL CANADA INC.

ST. CLAIR RIVER, SARNIA, ONTARIO.

APRIL 1996



SURGICAL ENVIRONMENTAL DREDGING LEVEL - CUT® WITH OVERLAPPING SIDEPLATES

CABLE ARM INC.

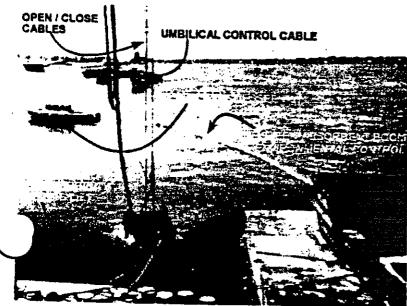
INNOVATIVE CLAMSHELL BUCKETS FOR THE 21ST CENTURY

3452 WEST JEFFERSON AVE., TRENTON, MICHIGAN 48183-2939

World Wide Web: http://www.ili.net/~cablearm/ Email: cablearm@ili.net

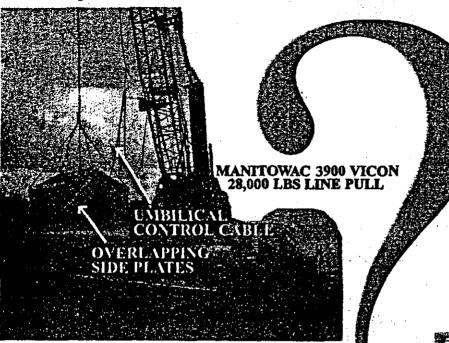
AROO 1486

Fax (313) 676-1345



Cable Arm Clamshell

'Vhy use an Environmental Clamshell Bucket





Outfalls Superfund Site River Raisin, Monroe MI. 25,000y³ Removed (PCB's)

Dredger: Luedtke Engineering Company Frankfort, Michigan

HIGHLIGHTS

- *SIDE PLATES OVERLAP TO REDUCE SEDIMENT LOSS ON CLOSURE
- *DRAINS WATER FROM ABOVE SEDIMENT / WATER INTERFACE AT SURFACE
- *LOW SUCTION / LOW TURBIDITY IN LIFTING
- *HIGH SOLID -- LIQUID RATIO IN SHALLOW SEDIMENT REMOVAL
- *SAFETY (SEDIMENT CONTAINMENT)
- *PRECISION (EXACT XYZ PLACEMENT)
- *CLEANING VIBRATORS
- ***Z AXIS DEPTH OF CUT**

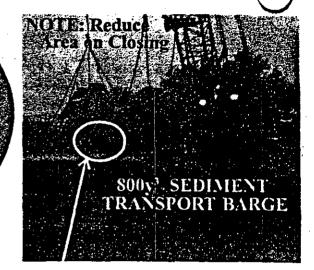
Cable Arm Clamshell

PH. (313) 676-6108 Area Code (734) Fax (313) 676-1345

http://www.ili.net/~cablearm/ e-mail cablearm@ili.net

Concept - Design - Reality

International Dredging Review, September/October 1997



Side Plates Overlap to Reduce Sediment Loss On Closure

5y' 8' N' 18' FOOTPRINE
BUCKET LOADING DUMP TRUCK
FROM TRANSPORT BARGE

6y' 10' X 18' FOOTPRINT
Sediment Dredging Bucket



LEVEL CUT

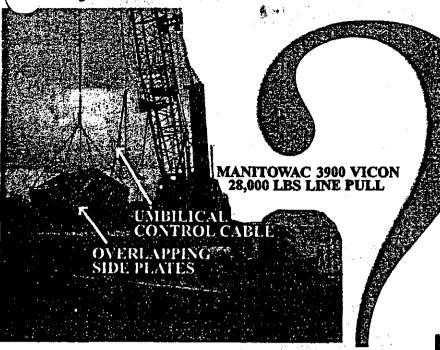
SHALLOW SEDIMENT REMOVAL =

LOW WATER CONTENT

OVERLAPPING SIDE PLATES

Cable Arm Clamshell

Why use an Environmental Clamshell Bucket



800v SEDIMENT TRANSPORT BARGE

Side Plates Overlap to Reduce Sediment Loss On Closure

NOTE: Reduce

CONTAMINATED SEDIMENT REMOVAL

Outfalls Superfund Site River Raisin, Monroe MI. 25,000y³ Removed (PCB's)

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HIGHLIGHTS

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- *PRECISION (EXACT XYZ PLACEMENT)
- *CLEANING VIBRATORS
- *Z AXIS DEPTH OF CUT

Cable Arm Clamshell

PH. (313) 676-6108 Area Code 1734) Fax (313) 676-1345

http://www.ili.net/~cablearm/

e-mail cablearm@ili.net

Concept - Design - Reality

5y` 8 X 18 FOOTPRINT BUCKET LOADING DUMP TRUCK FROM TRANSPORT BARGE

6y³ 10° X 18° FOOTPRINT Sediment Dredging Bucket



BIG FOOTPRINT

LEVEL CUT

SHALLOW SEDIMENT REMOVAL



LOW WATER **CONTENT**



A R O O 1 4 8 8

duced seven sons of their own; generating a new company name by 1976. Michael Elia's brother, Richard A., now serves as executive vice president. Laurence A is vice president, and cousins Dena M. Armstrong and Alan Jr. are treasurer and project manager, respectively. Chief Financial Officer William J. McDermott, a non-relative who joined Sevenson in 1975, has been there long

enough to be counted as family as well. In the late 1970s, fate untervened to steer Sevenson into the cleanup busness. The 1978 toxic disaster of Love Canal was 10 minutes from our office. says Larry Eliz. In fact: Eliz 3 failter and uncle built the school under which much of the contaminants were found buried. Already hur a britough compets non-and-low margins in construction. Seemson opted to my environmental work. The immorant letter the contraction contraction of the marginal contraction.

remediation contractation can altern vas declared a tederal disaster are authorised with early 1/0 amilhor of miles are work over 1 linears says funce that he tops of minutes became occurs with a man mismost.

Appressive Superimor gransmon from a government lediptogram to one largely run by corporate polluters has boosted Sevensons storement he firms hard-tollar low overnead mentality has endeated a to inapy owners looking to missis cleaming quickly and on burger his an aggressive from that those what is careful and what is and those what is careful and what is and those what is careful and what is and those what is careful and what is and those what is careful and what is and there is no whimpering with a way was a superior and what is and those what is careful and what is and there is no whimpering with the same and the careful and the same and what is and the careful and what is and the careful and what is and the careful and what is and the careful and what is and the careful and what is and the careful and what is and the careful and what is and the careful and the There is no whimpering, sais WW. Moore III. Gleanup sue managerifor Philadelphia chemical firm Rohm & Haas at its Lipari Landfill site in Pitman, N.J. He credits the firm for share ing a year off the original three year. cleanup schedule.

Other clients agree. On a \$7-million PCB cleanup soon to finishiana General Motors Corp. riverfront site in Massena, N.Y., Sevenson presented a contract that was no contingency, guaran-teed lump sum, says Jim Hartnett. GM's plant cleamip manager there have been no change orders, and none is pending."

Mike Elia is blunt about the firm's philosophy. We will assume the risk out a project, he says. If the estimate is accurate and the risk is controlled, we: will reap a high margin.

Clients point to strong project involvement by top managers, particularly Mike Elia. Harmett says the Sevenson company jet was a familiar sight in the beginning of his project. "Mike isn't in the office three days out of every week because he is out visiting projects and clients," says McDermott. The attention is also directed to staff, engendering fierce loyalty. There's no one who can

read and handle people better than Mike," says Jack Brueckl, corporate project manager and a 13 year veteran. We're growing old together its not just employer and employee. For the Elias, the company is not just a 9-to-5 job. When we're together socially, a lot of business is conducted," says Rick. Sevenson went public in 1989 to

fund more complex client demands. I from the Omaha division: Ironically, Ownership is still concentrated with

gion. It has also jumped into Defense Dept. megacontracting, although not without pain. Sevenson's first teaming effort on 2.\$330-million Corps of Fgineers Total Environmental Res tion Contract was a bust.

Unfazed the firm is now linked with ICE Kaiser Engineers Inc., Fairfax, Va. on a \$300-million TERC due out soon Sevenson is on the team as a small busi-



the three PliassAlar Jeland McDesmote holding 45% The released 200,000 shares last year under pressure from Wall Street, but, we are still the princi-pal investors and we reliant interested in pumping up the firm for others, says McDermott, Even so, Eirst Analysis Securities Corp., Chicago, recently raised its 1995 earnings per share estimate for evensor to \$1.69 from \$1.62, based on revenue growth.

Optimistic Superfund's current budget woes concern Sevenson, but Mike Elia is optimistic about near term prospects. If the program is shrunk, contracts will be bid aggressively and margins; will suffer," he says. Already, the firm's backlog is lower than he would like. He also is disappointed at the recent loss of a \$40-million cleanup at a Ford Motor Co. plant to J.A. Jones Inc., Charlotte, N.C.

Sevenson is trying to cushion itself by diversifying its contract mix. The firm has been pleased with returns in the "indefinite delivery" contracting arena. It now has \$11 million of work under a \$50-million U.S. Environmental Protection Agency Pre-placed Remedial Action contract won in the New York re-

ness qualityme under the new federal 87.44 designation because it has less than 500 temployees. Mike Elia hopes this vall lead to Dept, of Energy work, since Kanser if active in that market Sevensones appeal has brought a

number of the big boys to its door, but the firm is resisting an acquisition. T don speed to take orders from people who liney less about the business than I do: says Mike Elia McDermott notes some firms refuctance to link because of how committed we are to hard-dollar contracting." Sevenson has acquired two small technology firms to boost its arsenal but we're not targeting acquisition for growth, says Rick Elia

Even so, executives are adjusting to managing a larger firm. Tim not sure you can be a \$500 million firm with the same kind of organization," says Rohm & Haas Moore. He points to Sevenson's lack of sophisticated computerization and inhouse engineering. But Sevenson's officials insist customers value its traditional service. "Performance makes us one of the leade says Rick Elia. "We do what we say."

By Debra K. Rubin

SEVENSON ENV. SERVICES

Summary of Experience: DREDGING, DEWATERING AND PORTABLE WATER TREATMENT

Project Name and Location	Contract Value (000's)	Contact for Reference	Dredging :	Dewatering	Water Treatment
RCRA LAGOON CLOUSRE Perth Amboy, NJ	20,000	Confidential per Request	✓	√	✓
BEAVER CREEK IMPOUNDMENT Bayard, WV	2,400	Mr. Ed Moore 304-285-2233	✓		
BRINE SLUDGE SEPARATION New Johnnonville, TN	500	Mr. Jim Merkle 931-535-7779		✓	
DALECARLIA RESERVOIR Washington, DC	7,500	Mr. Dave MacGregor 202-764-2774	√	✓	
PCB SEDIMENT REMOVAL River Raisin Monroe, MI	6,000	Ms. Pam Dodt 313-323-7808	✓	1	✓
'ARI LANDFILL nan, NJ	40,000	Mr. William Moore 609-387-3467		√	√
PCB SEDIMENT REMOVAL St. Lawrence River Massena, NY	7,500	Mr. Jim Hartnett 315-764-2239	✓	✓	✓
MARATHON BATTERY SITE Hudson River Cold Spring, NY	40,000	Mr. Jim Cronmiller 440-953-5044	✓	✓	✓
RECRA POND CLOSURE Trenton, MI	5,500	Mr Pat Pearce 313-671-4509	√	✓	√
GILL CREEK SITE Niagara River Niagara Falls, NY	7,500	Mr. James McClincy 716-278-5795	✓	1	✓
CREEKSIDE GOLF COURSE Tonawanda Creek Amherst, NY	1,400	Mr. Jim Havass 713-215-7823		1	
FRONTIER CHEMICAL SITE Pendleton, NY	3,600	Mr. John Burns 423-336-4057		✓	√
PCB SEDIMENT REMOVAL Pawtuxet River Conston, RI	2,000	Mr. Matt Watson 908-914-9153	1	√	√

Dredge List Page 2 of 2

Project Name and Location	Contract Value (000's)	Contact for Reference	Dredging	Dewatering	Water Treatment
METALTEC/AEROSYSTEMS Franklin, NJ	3,400	Mr. George Buk 732-389-3040		1	1
SALTVILLE DISPOSAL SITE Saltville, VA	2,000	Mr. John Burns 423-336-4057		√	1
RIDEAU RIVER RECLAMATION Ottawa, Ontario	1,250	Mr. Lloyd Moreley 613-560-1288	✓	✓	√ /
NEW LYME LANDFILL Ashtabula, OH	16,500	Ms. Wren Wilson 304-576-9901			✓
LOVE CANAL SITE Black & Bergholtz Creeks Niagara Falls, NY	12,600	Mr. Bob Schick 518-474-2121		✓	√

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FOCUS ON ENVIRONMENT

Family-run cleanup firm grows up with Superfund program



one veteran marketing execut large cleanup contractor. "The always have the know how of wri posals or of good marketing, have the know-how of gettin.

Who's who. Sevenson has t ting a lot done in the years th Superfund have grown up t The firm is a veteran of 46 S site cleanups, including so most complex and controve ects. It has been busy on othe fronts as well, claiming 50 worth \$500 million complete Its work force is now at a r and projected revenue this exceed \$95 million. "Our straightforward," says Mich 43, president and CEO. "W project for the price quote the challenge of constructi and bringing them in ahe

Sevenson's contracting re deeper than its environn Elia's architect grandfathe started in the building 1917, and his four sons e

ENVIRONMENTAL DREDGING WITH MECHANICAL CLAMSHELL BUCKETS



Mechanical dredging using clamshell buckets can be done successfully in Environmentally sensitive projects that require a minimum increase in turbidity. Cable Arm Clamshell Inc. custom manufactures clamshell buckets. The Environmental clamshells are designed with overlapping side plates to reduce windrowing and loss of material from lateral flow. The product has been used successfully in projects that have turbidity limitations (as low as <30% of background within 30 meters of dredging point).

A major barrier is not the technology, but the mind set-"Cycle Time" rules. Minimizing turbidity requires a longer cycle time, therefore, procedure and a cost effective design plan are essential. The best equipment will not function unless the "procedures" are followed.

The clamshell bucket is part of the Cable Arm System that includes, process and procedure that: identifies the appropriate claimshell bucket for the available equipment, designs the work flow plan to included bucket decontamination and transportation of sediment, configures bucket XY positioning system from the crane specifications, and integrated the navigational system with the tide and clamshell depth controls.

A critical procedure is the wash cycle. The external surface of the bucket has minimum contact with the sediment (25% of the side walls), therefore, few suspended solids are distributed through the water column during elevation. When the bucket leaves the water, no visible material appears on the surface. After the material has been discharged - aided by vibrators (design option), the bucket should be placed into a wash tank and decontaminated. The wash cycle is vital for environmental dredging. Not all material can be discharged - there is a layer of dredged material covering the entire inside surface and usually solid material is stuck in corners which can not be dislodged by the vibrators. This material will contaminate the water column during the lowering cycle, resulting in an increase in turbidity.

A major concern expressed by the contractors and engineers is the increased cycle time for the decontamination process. A "decontamination process" should be part of all environmental dredging tendering documents. If the site is monitored for turbidity, the cost for non-compliance can be significant.

Cycle time can also be increased due to sensor deployment and real time instrumentation control. The time for accurately positioning the clamshell bucket can reduce the removal of excessive material and low solids which increases the project costs.

The Cable Arm System has been successful in many major cleanup projects requiring the removal of contaminated sediment (DOW CANADA, Hexachlorabutadiene, St. Clair River - FORD MOTOR CO., PCB, River Raisin - NORTHERN WOODS PRESERVE, Creosote, Thunder Bay - ENVIRONMENT CANADA, Sediment, Toronto, Hamilton, and Pickering Nuclear Plant). In all cases the turbidity criteria was achieved.

Paying attention to procedures pays.



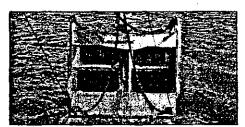
A special challenge

Environmental dredging project at Thunder Bay required a creative approach and sophisticated new technology

he Northern Wood Preservers site on the Thunder Bay waterfront bears the legacy of a bygone industrial era. Over a span of several decades, leakage of creosote and other chemicals from the site into the Thunder Bay harbor created a pocket of contaminated sediment toxic enough to be designated by

the International Joint Commission as an environmental "Area of Concern" in the Great Lakes.

The extent of contamination in the lakebed sediments surrounding the site are well documented. Twenty years of



Used for the Thunder Bay project was a Cable Arm clamshell, specially designed for dredging contaminated sediment.

studies on the site—on which wood preserving activities were carried out for over 50 years—identified the contaminants as mainly polycyclic aromatic hydrocarbons (PAHs—a constituent of creosote) with low levels of PCP (also a wood preservative) and dioxins/furans.

The result has been degradation of the aquatic environment, with areas acutely lethal to fish and the benthic community. Following a number of studies that concluded with unaffordable solutions to the problem, DST Consulting Engineers Inc. of Thunder Bay finally developed in 1993 an unconventional, yet

more practical clean-up strategy involving three industrial partners: Abitibi-Price, Canadian National Railways and Northern Wood Preservers. CN owned the land which was sold to Northern Wood Preservers and Abitibi once operated the site.

DST's proposal, the Northern Wood Preservers Alternative Remediation Concept (NOWPARC), involved:

- A site specific risk based analysis for identifying the extent of the clean-up.
- A low-cost clay barrier around virtually the entire site.
- An area of reclaimed land to provide space for sediment treatment.
- A buffer zone between industry and waterfront.
 - New habitat for fish and wildlife.
- Improved risk management and the potential for a more effective industrial operation.

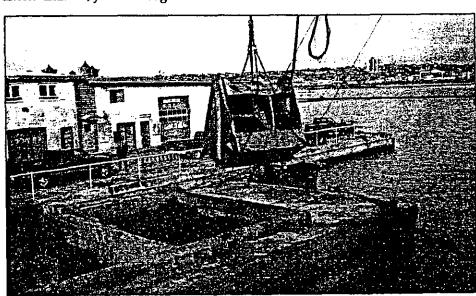
The cost of the project was budgeted at C\$9.3 million, less than half the cost of conventional solutions. DST has since used the same risk-based process at two additional clean-up sites.

Following the addition of two more partners, Environment Canada and the Ontario Ministry of Environment, the project was further developed and put through the rigorous requirements of an Environment Assessment which harmonized the federal and provincial processes.

Another key player was the Public Advisory Committee of the Thunder Bay Remedial Action Plan which provided significant review and input to the project. In May, 1997, the Canadian Minister of Environment formally approved the project.

The plan ensured that all acutely toxic sediments would be removed and treated while most of the low level contaminants would be remediated through capping with fill. Such intrinsic remediation was determined suitable for the remaining low level contaminants in the shipping channel since studies have indicated that natural degradation can solve this part of the problem in only a few years.

Dredging activity at the site was begun in the summer of 1997 by Pierre Gagne Contracting Ltd. and employed some interesting new technology of its own. A Cable Arm clamshell, designed specifically for environmental dredging, was used to remove 13,000 cubic meters of contaminated sediment (see story on page 54). In addition, a retired Great Lakes vessel, the former Canada Steamship Lines bulker Saguenay, was acquired and towed to the site to provide temporary storage of the dredged material.



Some 13,000 cubic meters of sediment is to be removed from the Thunder Bay harbor for treatment.

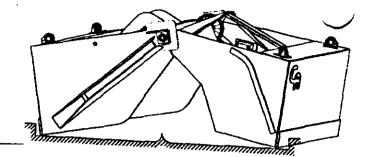
ENVIRONMENTAL DREDGING

TURBIDITY CONTROL

Operating Procedure: Suspended Solids Monitoring

References: Ma

Manufacturer's Manual



A. Routine Daily Activities

The following activities should take place before dredging starts each day or if dredging has been suspended during the day for any reason.

- Ensure computer recording system is switched on and operating manually
- 2. Suspended Solids Background Determination

The level of background total suspended solids (TSS) in the water column XX meters downstream from the dredging site will have to be determined before dredging starts, so that the appropriate alert level can be set. It will be assumed that any increase above the background is due to the dredging operation until an updated background can be made.

The instrument readings will be observed for a period of three minutes for each sensor and the average readings determined. The higher of the average readings will be considered the background and recorded. The alert alarm setting will be input at XXX mg/l above the background

The following actions should be performed daily, but can be done at any time during the day.

3. Cleaning of Suspended Solids Sensors

The sensor has an infra red lamp in the cut out just above the end of the stainless steel sensor. The surfaces must be cleaned daily with a soft clean cloth to ensure that there is no reduction in transmission. This will involve raising the sensor out of the water. Only one sensor may be removed from service at a time.

Cleaning the sensor may show a step change down in the readings due to greater transmission. The size of the step should be noted and the alarm levels adjusted to account for the change. This is not a full background calibration, it merely adjusts the previous background calibration.

4. Calibration of Suspended Solids Sensors

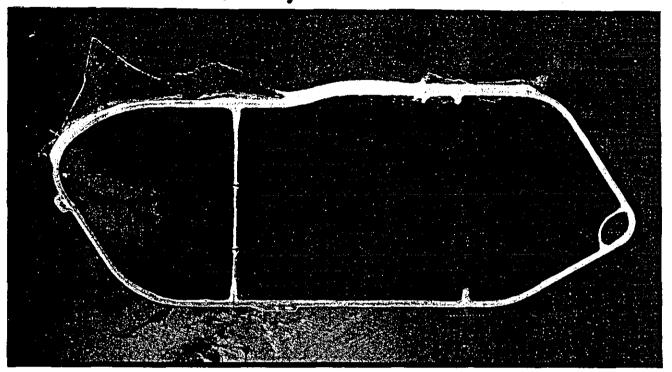
Once the sensor has been cleaned, a calibration check will be made. This will involve shaking up the calibration container which contains a known amount of solid material (site sediment sample) to ensure the solids are fully suspended. The reading of the sensor will be recorded and compared with the standard to determine whether recalibration of the instrument is required. An accuracy of +/- XXX mg/l will be acceptable. There will be at least two standards available.

Note: The project supervisor should be informed that the Alert or Shutdown Dredging alarms may be triggered during the calibration as one of the standards os likely to be above the normal background.

If recalibration is required, the details must be logged and the manufacturer's procedures followed.

A CONTRACTOR OF THE PROPERTY O

Hart-Miller Island, Maryland



The completed containment area at Hart-Miller Island. Below, a crane prepares to offload roadhed material. At hottom, a Gradall hegins dressing foundation stone laid on top of filter cloth.

Project

Diked Containment Area Construction

Customer

Maryland Port Administration

Location

Chesapeake Bay at Baltimore, Maryland

Contract

Construct a 1,140-acre (460-hectare) containment area within an armored 29,000-ft (8,8400-m) sand dike to accept more than 50 million yd³ (38 million m³) of dredged material from Baltimore's port deepening and maintenance projects

Description

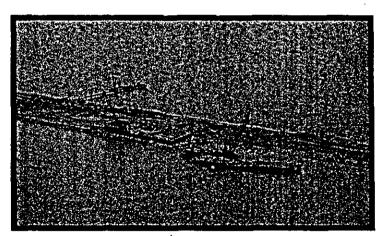
- Construct a dike that rises to 18 ft (5.5 m) above mean low water, and is 20 ft (6.1 m) wide at its top, 164 ft (50 m) at mean low water
- Construct weir structures and perimeter road
- Construct a mechanical unloading facility and two hydraulic pumpout berthing areas

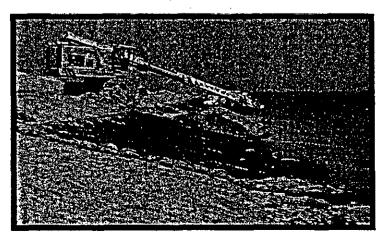
Quantities

- Disposal of unsuitable foundation: 2.5 million yd³ (1.9 million m³)
- Hydraulic fill: 7.5 million yd³ (5.7 million m³)
- Stone slope protection: 460,000 tons (418,000 metric tons)
- Filter cloth: 2.25 million ft² (208,000 m²)
- Roadway construction: 600,000 ft² (55,800 m²)

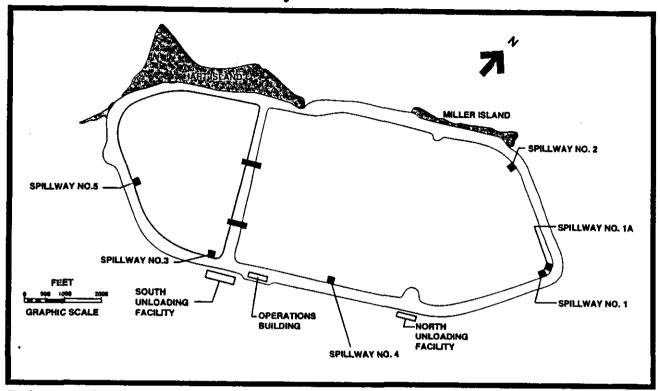
Equipment Used

- Hydraulic cutterhead dredges *Illinois* and *Georgia*
- Cranes No. 2 & 3 (Manitowoc 4500s)

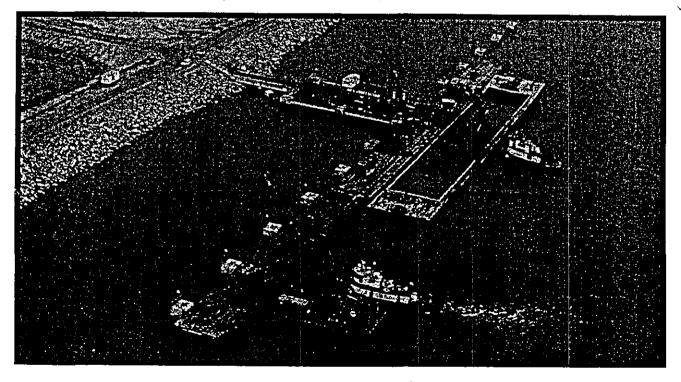




Hart-Miller Island, Maryland



Facility Layout: Since its construction, Great Lakes has placed more than $44,000,000 \text{ yd}^3$ (33,640,000 m^3) in the containment facility. Below, hydraulic Unloader No. 2 pumps material from a barge at the south unloading facility.





Great Lakes Dredge & Dock Company 2122 York Road Oak Brook, Illinois 60521 U.S.A. 708/574-3000 708/574-2909 fax

APPENDIX 7

Turbidity Curtain Information

VENDOR INFORMATION

Turbidity Curtains - Gunderboom



GUNDERBOOM, I P.O. Box 222094 Anchorage, Alaska 99522-2094 TEL: (907) 349-7008 FAX: (907) 344-5172 e-mail: gboom@micronet.net

VIA FEDERAL EXPRESS

January 19, 2000

Mr. Phil McQuiston
Ogden Environmental and Energy Services Co., Inc.
1777 Sentry Parkway West
Abington Hall, Suite 300
Blue Bell, PA 19422

Re: Gunderboom Contaminated Particulate Control System (CPCS™)

Metal Bank NPL Site

Dear Mr. McQuiston:

This letter and the attached information is provided in response to our most recent communications regarding the potential use of our CPCSTM barrier system at the Metal Bank NPL Site.

The GUNDERBOOM[®] systems are described in more detail in the attached information. I would, however, like to point out several important aspects of our systems that specifically apply to your project.

The first "Gunderboom" was utilized on a dredging project in Alaska and came to life as a result of the inventor's need to tackle a specific type of problem that traditional "silt curtains" could not handle. It has gone on from that point as an <u>engineered</u> solution for non-traditional applications. The dredging of contaminated materials falls into this category. There are many subtleties to the design and implementation of a system for these applications, but the highlight points are:

- > GUNDERBOOM® Systems are designed to maintain position and are constructed of a unique fiber system that provides high strength, no biofouling and the ability to withstand current flows in the 6 fps range, where necessary.
- > The systems can be constructed in one piece, so there are no seams to leak or give way.
- > The engineered nature of the system provides a balance between the project goal, materials utilized, mooring system specified and performance. An entirely engineered installation.

Typically, we enter into these projects in phases and it would appear a program that follows the format described below would be appropriate for the project we have discussed.

PHASE I - Preliminary Investigation

This is sometimes referred to as a "Desk Top Study" as it involves the collection, review, and dissemination of existing data that may be available from in-house sources, agencies, publications and so on. The areas to be investigated are:

- Detailed site mapping to include shoreline structures, submerged fixtures and general layout.
- Nearshore and Offshore Bathymetry
- River floor and embankment geotechnical data for anchoring
- River current data including speed, direction, fluctuation, local considerations and anomalies, if applicable.
- Debris transport relevant to type and degree of materials to be anticipated, including logs, trash micro-algae, sea grasses, etc.
- Wind and wave considerations, including fetch.
- Tidal current and elevation changes, if applicable.
- General construction plan and implementation
- Permitting, navigational and local political issues, if any.

Phase I results in a Summary Report that:

- Summarizes findings from the Desk Top Study to include recommendations for field studies where adequate information does not exist.
- Provide concept plan and layout based on findings.
- Generate preliminary cost estimates for conceptual plan.
- Develop critical path schedule for balance of Phases leading to installation of the CPCSTM.
- Develop cost estimates for Phase II based on the findings in Phase I.

PHASE II - Complete Data Acquisition

The report that is generated as a function of the Phase I effort will provide a detailed list of action items and tasks required to move into the final design phase. This aspect of the project could be extensive or it could be relatively minor, depending entirely on what information exists and is available to our staff. The types of additional efforts that may be required and would be undertaken in Phase II are:

- Confirmation of bathymetry to include side scan sonar.
- Collection of geotechnical information for anchoring considerations including an anchor lateral pull test.
- Current velocity and direction studies.
- Bench scale/pilot studies to simulate barrier performance.
- Attend agency and public meetings.

The balance of the project is then divided into Final Design, CPCSTM Fabrication and Shipping, Installation, Adjustments & Training and any additional monitoring services that may be required.

The purpose of this letter and the attached information is to give you a basic overview of what our product(s) is/are and how we implement these engineered applications. If I can provide anything further, or if you would like to move forward with the project, please let us know and we can provide a more definitive proposal.

I have also attached a reasonable representative sample of the barrier curtain material. By "reasonable representative", I mean it is very close to the make-up of the material that would be used for this application; however, there would probably be some minor changes to the composition in thickness of the material.

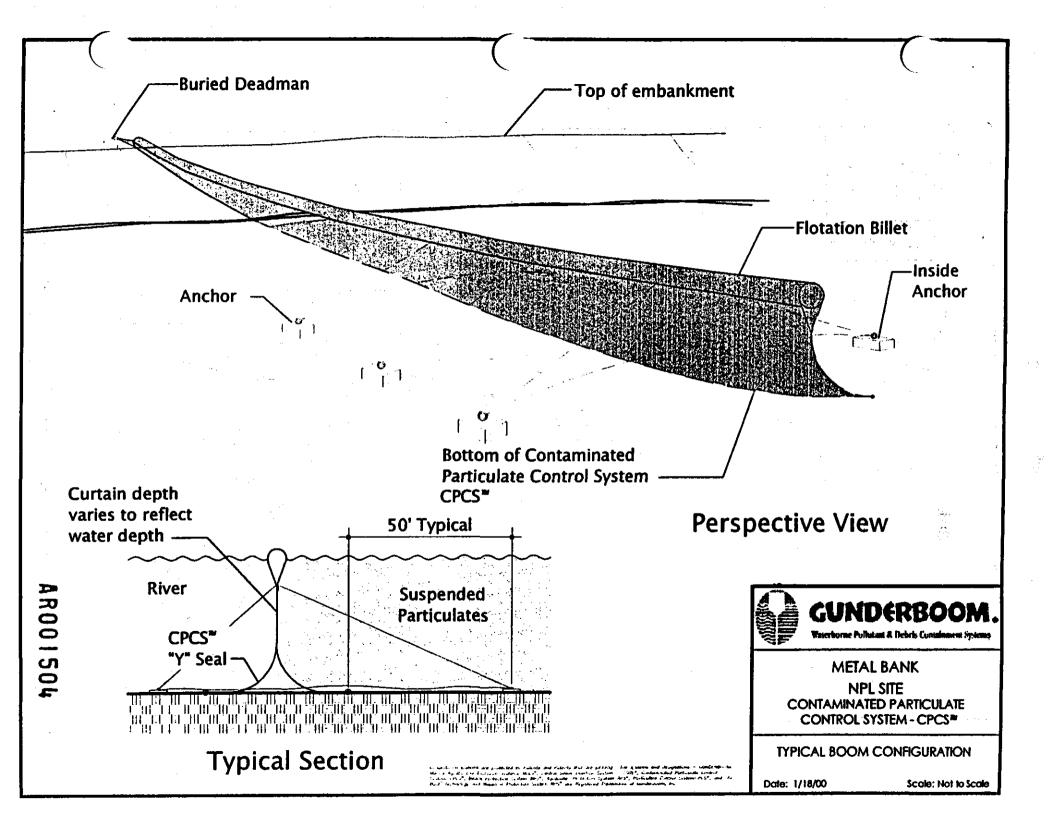
I appreciate your interest in Gunderboom® Systems and look forward to being of service to Ogden Environmental.

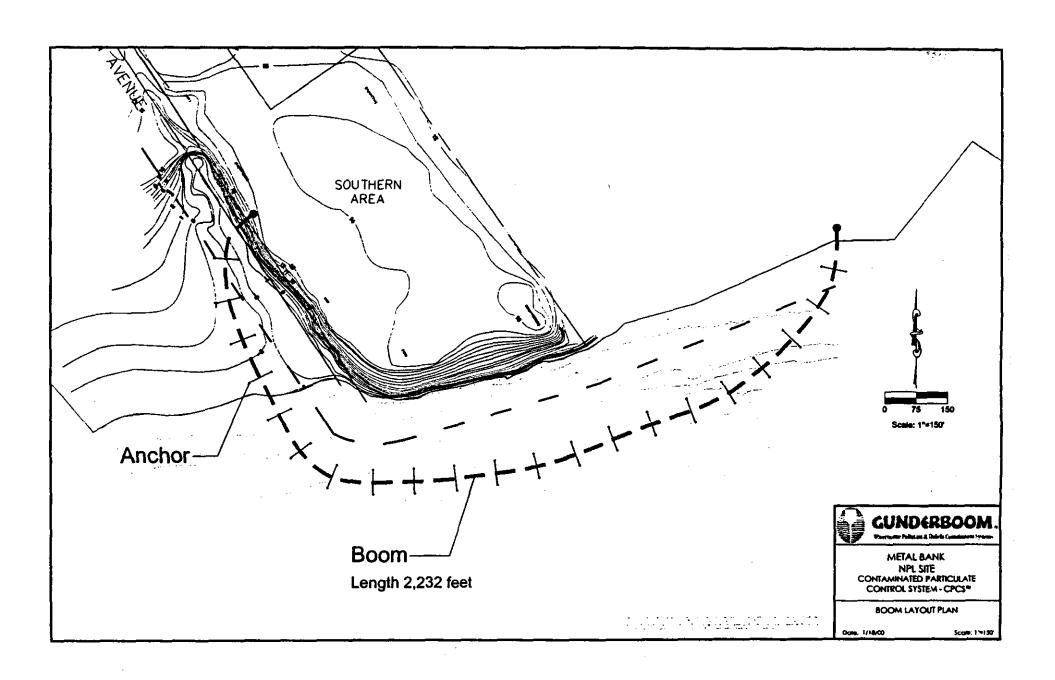
Sincerely,

GUNDERBOOM, INC.

Harold B. Dreyer

President









GUNDERBOOM® Particulate Control System (PCS™)

AN IN-WATER FILTER BARRIER TO PREVENT MIGRATION OF PARTICULATES FROM DREDGING. DREDGE SPOIL DISPOSAL, CONTAMINATED SEDIMENT REMOVAL, MINING DISCHARGES. STORM WATER OR OTHER SOURCES

Introduction

Gunderboom engineers, manufactures, and installs systems to prevent migration of particulates, contaminants and pathogenic microbes within a water body. From its first dredge-spoil water-quality protection system in Kachemak Bay, Alaska in 1986, Gunderboom has refined its' system designs for applications ranging from protection of bathing beaches (from particulates, bacteria and waterborne debris) to exclusion of fish eggs and larvae from power-plant cooling-water system intakes. Whether preventing particulate migration

from a source or preventing particulates from reaching a resource, dredgingcontaminated sediment removal, settling pond operation, and control of storm-waterderived contaminants are among the wide range of GUNDERBOOM® applications

> The Gunderboom did an admirable job in protecting water quality during dredging operations in Homer, Alaska, where tidal changes are the largest in North America. That was what our egency required." Tim Rumfelt

Alaska Department of Environmental Conservation



A GUNDERBOOM PC5 is a patented* full-water-depth filter curtain comprised of treated polypropylene/ polyester fabric, suspended by flotation billets on the water's surface and secured in place with anchoring systems. Systems are custom-designed and deployed to prevent the migration of particulates, pathogenic microorganisms and other particulate-associated contaminates. For example, systems are designed to prevent migration of particulates and contaminants from dredging activities. A system could be deployed to fully enclose a project to isolate particulates and contaminates from escaping into surrounding areas.





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AR001506





What factors affect the design of a GUNDERBOOM® PCS"?

Each GUNDERBOOM® PCS is customdesigned to account for factors, including:

- > Nature and degree of suspended solids and contamination.
- > Location; fixed or moving operation (such as channel dredging)
- > Flow rate of water flow to be filtered.
- > Physical factors, including bathymetry, bottom conditions and configuration of the water body.
- > Water body characteristics, including elevation changes, currents and wind-induced wave action.
- > Seasonality of the problem; probable duration of deployment.

What are the filtering properties: how effective is a GUNDERBOOM® PC5™?

The GUNDERSOOM³ fabric is manufactured as a matting of minute fibers and, as such, has no designated opening size. The Apparent Opening Size (AOS) is determined by sieve analysis and has been determined to be 20 microns or less.

The GUNDERBOOM® has been found to be effective in reducing turbidity, suspended solids, coliform bacteria, and particulate-associated

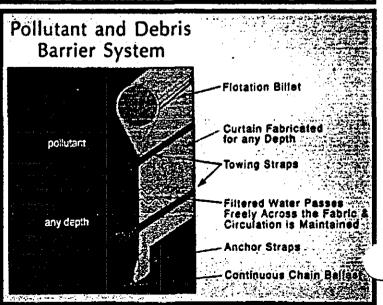
contaminants. Statistically-significant reductions have been observed for all parameters. Highest apparent differences observed in paired samples were on the order of 80-99% (or from 5-to 100:1) for turbidity; 99% (>25:1) for TSS; and, for coliforms, on the order of 63-to-99% (2.5-100:1). A USEPA-sponsored bench-scale testing program underway during 1999 will provide more specific data on filtering capacity.

What data are available to evaluate GUNDERBOOM® systems' performance?

GUNDERBOOM systems have been utilized for a number of particulate-control applications. including storm-water control, maintenance dredging, dredging for removal of contaminated sediments and bathing beach protection from high counts of coliform and floatables, along with surface drinking water supply protection. number of the applications, performance data have been acquired by the PCS purchasers. Gunderboom has contracted to have an independent evaluation made of the performance data that is available for a number of these applications. The Performance Evaluations are available to prospective clients and regulators upon request. These include:

- > Port of Olympia , Pilot Dredging Project, Creosote Contaminated Sails
- > Kensico Reservoir, Storm Water, Bacteria & Sediment Control
- Sea Cliff Beach, Bathing Beach Protection Bacteria & Flotable Control
- Manageneck Village Beach, Bathing Beach Protection, Bacteria & flotable Control
- Gardiners Creek, Storm Water Control, Bacterial & Flotable Control

Category	Before PCS	After PCS
Total Suspended Solids TSS (mg/L)	9.9	0.7
Turbidity (NTU)	20.0	1.0
Coliforms (MPN)	>2400	22.0

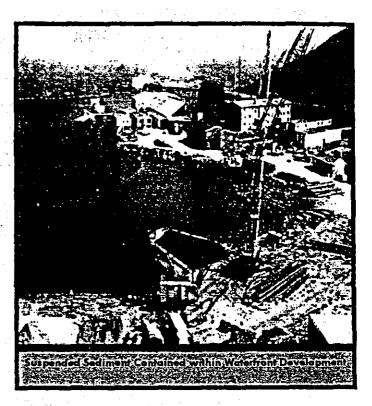




How is a GUNDERBOOM® deployed?

Deployment is simple, usually requiring several people, a small vessel, and level surface near the water (i.e. beach, dock, etc.). The GUNDERBOOM® is delivered to the deployment site folded and stockpiled on a large pallet. Floatation units are stacked on pallets next to the blanket-like boom, and when ready to deploy, are inserted by hand into precut access slits in the boom's top hood.

Once in the water, the GUNDERBOOM® is towed into position. Anchors are deployed at predesigned locations, generally to help retain the boom's shape. For a typical installation, the two primary anchoring points are at either end of the boom. The PCS® is designed to seal at the two ends as well as with the bottom sediment to provide a near-impenetrable seal against material transfer. Because the boom is flexible, it will cling to the shoreline, providing a near-seal against material transfer. Most boom deployments can be accomplished within two-to-three days, barring problems with logistics and/or weather.



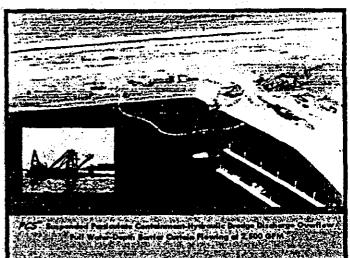
What kind of flow will a PCS™ System handle?

For reduction for particulates at such concentrations as are normally found in stormwater, Gunderboom begins it's design with a target of boom dimensions that will achieve filtration at a rate of approximately 3-5 gpm per square foot of submerged fabric. Other systems may be designed to pass much less water or in excess of 10 gpm/square foot, depending on the target particulates and other factors.

What about maintenance and durability?

In general, there is limited maintenance required for a GUNDERBOOM² system. The boom has not shown a propensity to foul or become clogged where there is limited flow through. The material also tends to be non-biofouling. Natural motion of the boom tends to slough off any sediment buildup.

For applications with high-flow rates for extended periods and which have significant suspended particulate oncentrations, Gunderboom has developed a double-fabric-layer PC5" with an "Air Burst" Technology cleaning system. This double-layer, "Air Burst" Technology cleaning system was developed for a continuous-high-flow



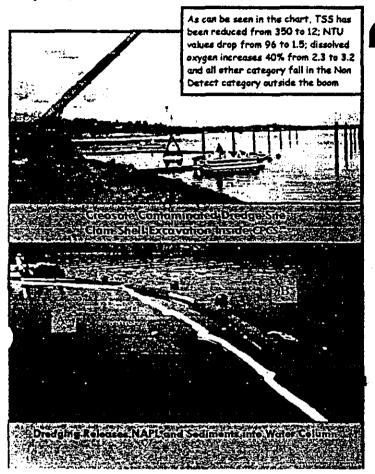
application in the silt-laden Hudson River and found to be effective in maintaining flow, even under those rigorous conditions. The system is fully automated and has run for several consecutive months with no failures.

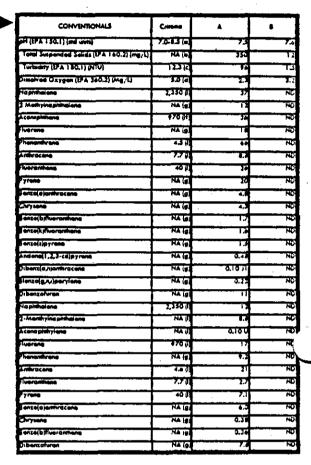
Most long-term deployments have been at locations with extreme tide, wave and current forces acting on them. Even so, these applications have all had multi-year success. A program of routine observations with an annual inspection is recommended. Gunderboom also offers an annual lease program that includes maintenance and repairs as needed to maintain a fully-functional system.



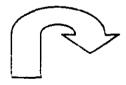
What is a Contaminated Particulate Control System (CPCS™)?

A modification to the standard PCSTM provides a full water- depth barrier for preventing the migration of contaminated sediments into surrounding waters during dredging and removal efforts. Results of a recent creosate-contaminated dredge project reflect the samples taken inside the contained dredge area (A) vs. outside the boom which is area (B).





How do I obtain more information about GUNDERBOOM® Systems?



For more information on GUNDERBOOM® filter barrier solutions, SEE OUR WEBSITE at www.gunderboom.com or contact us:

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Gunderboom systems are protected by Patents and Patents that are pending. The systems and designations:

System-MLESTM: Central Sewer O verflow System - CSOSM: Contaminated Particulate Control System

A quaculture Protection System - APSTM - Particulate Control System - PASTM and Am Burs - Tyle Control

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GUNDERBOOM, INC.

System Specification

BPSTM



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What information is available to evaluate the performance of GUNDERBOOM® systems?

How is a **GUNDERBOOM** deployed?

What kind of flow will a BPSth system handle?

What about maintenance and durability?

What are GUNDERBOOM®
BPS™ options?

How do I obtain more information about GUNDERBOOM® systems?

GUNDERBOOM® Beach Protection System

FOR PROTECTION OF SWIMMING BEACHES AND OTHER SHORELINE RESOURCES

Introduction

GUNDERBOOM® manufactures, installs and maintains custom-designed Beach Protection Systems® (BPS®) to prevent the migration of storm-water derived particulates and pathogenic microorganisms into swimming areas. The BPS® also keeps out flotables, jelly fish and other large materials and substantially improves water clarity.

For most applications, the GUNDERBOOM® BPS™ can be designed to meet state requirements and/or USEPA current recommended criteria. Gunderboom is tracking developments under EPA's 1999 Beach Action Plan to facilitate its ability to

The BP5 improves the

quality of the water

while also

Improving aesthetics and

providing e clean separation

of swimming areas

meet the most stringent requirements that may be developed.

The BPS™ is one specialized application of the GUNDERBOOM® Particulate Control Systems (PCS™).

What is a GUNDERBOOM® BPSTM?

A GUNDERBOOM® BPS™ is a patented* full-water-depth filter curtain comprised of treated polypropylene/polyester fabric suspended by flotation billets on the water's surface and secured in place with anchoring systems.

Sea Cliff Beach Boom

Systems are custom-designed to address the specific problems experienced at the beach area. Sources of water degradation are considered as are other uses of the water body.



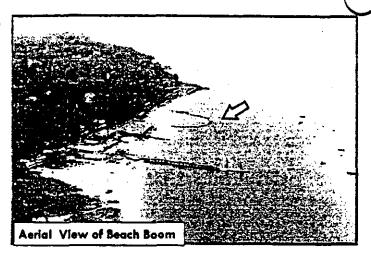
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Page 2

"hat factors affect the design of a GUNDERBOOM® BPS™?

Each GUNDERBOOM® BPS™ is custom designed to account for factors including:

- > Nature, degree, and source(s) of the contamination problem.
- > Beach usage characteristics.
- Static physical factors, including bathymetry, bottom conditions, and configuration of the water body.
- Dynamic physical factors, including currents, tides, and exposure to waves.



What are the filtering properties, and how effective is a GUNDERBOOM® BPS™?

Most GUNDERBOOM² filter fabrics are manufactured as a matting of minute fibers and as such, have no designed opening size. For one fabric, the Apparent Opening size (AOS) as determined by sieve analysis is approximately 20 microns.

The GUNDERBOOM® BPS™ has been found to be effective in reducing turbidity, suspended solids, and fecal and total coliforms. Based on data from paired samples taken inside and outside of the boom, statistically significant reductions have been observed for all parameters. Highest apparent differences observed in paired samples were on the order of 80-99% (or from 5-to 100:1) for turbidity; 99% (>25:1) for TSS; and for coliforms, on the order of 63-to-99% (2.5-100:1).

Representative values from a GUNDERBOOM® drinking-water reservoir application in early 1999, where the GUNDERBOOM® Particulate Control System enclosed a cove that received a high volume of storm-water flow were:

	Outside Boom	Inside Boom	Reduction
TS5 (mg/L)	9.9	0.7	92.9%
Turbidity (NTU)	20.0	1.0	95.8%
Coliforms (MPN)	>2400	22.0	99.1%

What information is available for evaluating the performance of GUNDERBOOM® systems?

Gunderboom is conducting a project to provide bench-scale testing as well as a full-scale system performance evaluation. The project is being funded by the U.S. Environmental Protection Agency, National Risk Management Laboratory, Office of Research and Development. Data from this program will provide more specific data on filtering capacity than has been achieved through ambient water measurements to date. Preliminary data will be available in the latter half of 1999.

GUNDERBOOM's systems have been utilized for a number of particulate-control applications, including storm water control, maintenance dredging, dredging for removal of contaminated sediments and surface drinking water supply protection along with bathing beach protection from high counts of coliform and flotables. For a number of the applications, performance data have been acquired by BP5TM purchasers. Gunderboom has contracted to have an independent evaluation

te of the performance data that are available for a number of use applications. The Performance Evaluations are available to prospective clients and regulators upon request. These include:

- Sea Cliff Beach, Bathing Beach Protection, Bacteria & Flotable Control
- Mamaroneck Village Beach, Bathirg Beach Protection, Bacteria & Flotable Control
- Kensico Reservoir, Storm Water, Bacteria & Sediment Control
- Gardiners Creek, Storm Water Control, Bacterial & Flotable Control
- Port of Olympia, Pilot Dredging Project, Cresote-Contaminated Soils



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How is a GUNDERBOOM® deployed?

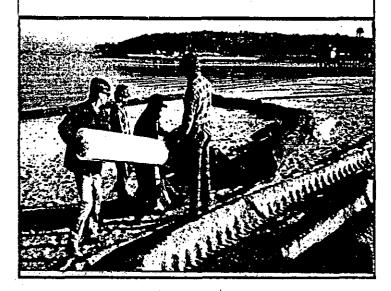
With the GUNDERBOOM BPSTM designed and custom-manufactured in advance, the deployment can be accomplished within one-to-several days. Deployment usually requires a small team of people, a suitable vessel, and a level surface near the water.

The GUNDERBOOM® is delivered to the deployment site folded and stockpiled on a large pallet. Floating units are stacked on pallets next to the blanket-like boom and, when ready to deploy, are inserted by hand into precut access slits in the boom's top hood.

The Anchor System is deployed at predesigned locations, generally to help retain the boom's shape. For a typical installation, the two primary anchoring points are at either end of the boom. Because the boom is flexible, it will cling to the shoreline-submerged terrain, providing a near-impenetrable seal against material transfer.

Once the GUNDERBOOM® is prepared and in the water, it is towed into position and anchors are attached.

Beach Boom Deployment at Sea Cliff Beach



What kind of flow will a BPS™ system handle?

Beach Protection Systems (BPSTM) are generally deployed to prevent the migration of materials with water moving into the beach area, and the size and configuration of the systems are dictated by beach managers. The capacity of the GUNDERBOOM® filter-material far exceeds what is normally required for maintaining good flow and minimizing turbidity and pathogens.

What about maintenance and durability?

In general, there is limited maintenance required while a GUNDERBOOMs system is deployed. The boom has not shown a propensity to foul or become clogged where there is limited flow-through and the material tends to be non-biofouling. Natural motion of the boom tends to slough off any sediment buildup. Gunderboom has developed a double-fabric-layer BP5 with an "Air Burst" Technology Cleaning System that may be recommended for long-term applications where sediment volume may be high and where boom movements may be expected to be low. This double-layer, "Air-Burst" Technology Cleaning System was developed for a continuous-igh-flow application in the silt-laden Hudson River and found to be effective in maintaining flow even under those rigorous conditions.

THE PERSON NAMED IN COLUMN TWO IS NOT THE OWNER.

Excerpt from Patricia Horlog's article in a Glen Cove, NY newspaper. "The Wounded Warrior" is the rueful nickname given to the Gunderboom by Sea Cliff Beach Committee Chairman, Carmine Calzonetti, because only two days after the experimental filtration device was installed in Sea Cliff waters it was assaulted by 1,000 gallons of Bunker C oil spilled from a freighter. "The Wounded Warrior" did a great job, "Carmine Calzonetti said. "It protected the beach from the oil....Ironically, it was the publicity surrounding the Gunderboom after it was used successfully in the aftermath of the Exxon "Valdez" oil spill, that first brought the device to Carmine Calzonetti's artention..."

Many long-term GUNDERBOOM¹ deployments have been at locations with extreme tide, wave and current forces acting on them. Even so, these applications have had multi-year success. Gunderboom recommends that a formal inspection and maintenance program be implemented to ensure that the BPSTM is fully functional and to minimize repair and replacement costs in the long term. Procedures for annual system removal, maintenance and storage are critical to the long life of the system. Gunderboom will provide recommended procedures for these activities. Alternatively, Gunderboom can provide these services as an adjunct to the sale of an installed system or under an annual system lease arrangement



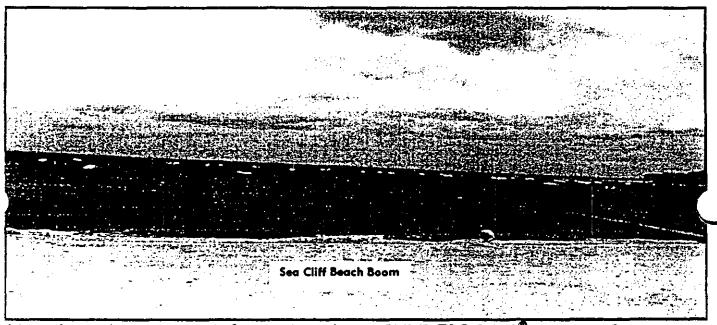
GUNDERBOOM, INC.

What are GUNDERBOOM® BPS™ options?

- > Boom Hood Material & Color.
- > Double Layer Filter System
- > Anchoring System, Pilings, Floating Walkway
- > "Air-Burst" Technology Cleaning System
- > Bird Deterrent System
- > Purchase vs. Lease.



Gunderboom can work with beach managers, environmental staff, and engineering consultants to develop the optimum program that matches the recreational considerations of the beach



How do I obtain more information about GUNDERBOOM® Systems?

West Coast



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'Gunderboom systems are protected by Patents and Patents that are pending. The systems and designations – GUNDERBOOM • Ma rine/Aquatic Life Exclusion System-MLESTM; Central Sewer Overflow System – CSOSTM; Contaminated Particulate Control System – CPCSTM; Beach Protection System – BPSTM; Aquaculture Protection System – APSTM; Particulate Control System – PCSTM and "Air Burst" Technology and Reservoir Protection System – RPSTM are Registered Trademarks of Gunderboom, Inc.





FOR EXCLUSION OF PLANKTONIC EGGS AND LARVAE AND SWIMMING ORGANISMS FROM
ENTRAINMENT IN COOLING WATER SYSTEM INTAKES

Introduction

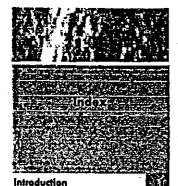
Gunderboom designs, engineers, manufactures, installs, and maintains Marine Life Exclusion Systems (MLES^m) to prevent the entrainment and impingement of ichthyoplankton and juvenile aquatic life at intake structures.

Gunderboom has manufactured and installed systems for control of particulates and the protection of marine and aquatic life since 1986. The MLESTM has been under development since 1995 when the first version was installed at a power-generation plant on the Hudson River in New York. For this project, Gunderboom engineers were engaged by the utility to develop new and more sophisticated technology to prevent the entrainment of planktonic fish eggs and larvae.

The system is now available to minimize or eliminate entrainment impacts, to respond to discharge requirements and to commence developing provisions of the Clean Water Act, Section 3168. The

installation of a MLESTM also eliminates or significantly reduces the entrainment and impingement of finfish and mobile invertebrate species. The MLESTM can be used to address an individual problem or situation, or may be incorporated as part of an overall strategy to manage 3168 compliance issues.





What is a
GUNDERBOOM® MLES™?

What factors affect the design of a GUNDERSOOM® MLES™?

What are the filtering properties; how effective is a GUNDERBOOM® MLES™?

What data are available to evaluate GUNDER800M® Systems' performance?

How is a GUNDERSOOM® deployed?

What kind of flow will an MLESTM System handle?

What about maintenance and durability?

What are GUNDERSOOM® MLES™ options?

How do I obtain more information about GUNDERBOOM® Systems?

What is a GUNDERBOOM® MLES™?

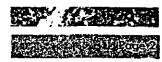
A GUNDERBOOM® MLES™ is a patented® full-water-depth filter curtain comprised of treated polypropylene/polyester fabric suspended by flotation billets on the water's surface and secured in place with anchoring systems. These systems can also be installed with pilings or other structured support. The MLES™ system consists of the following component parts:

- Polyvinyl reinforced hood with flotation billets sized to meet anticipated load requirements.
- Polypropylene mooring lines at top and bottom.
- Double panel barrier curtain of GUNDERBOOM® material, modified for flow requirements.
- Structural reinforcement straps, grommets and attachment points.
- Ballast chain in bottom sleeve.
- Automated and computerized "Air-Burst" Technology Curtain-Cleaning System.

Anchoring system array designed to carry intended loads considering the geophysical constraints of the facility.

GUNDERBOOM® systems are custom designed and deployed to provide for the passage of large volumes of water while excluding particulates. In the MLES™ application, the target particulates are planktonic and neustanic aganisms. The system is designed and installed to completely surround the intake structure, away from the shoreline. With the GUNDERBOOM® fully sealed against the seafloor and shoreline structures, all water passes through the fabric at a lower velocity, thus providing positive filtration of all water entering the facility's intake systems. Boom-curtain material is designed and fabricated so it will fit the contour of the bottom configuration surrounding the facility. The design process also addresses the interfaces with the facility's fixed structures at each end of the boom system.

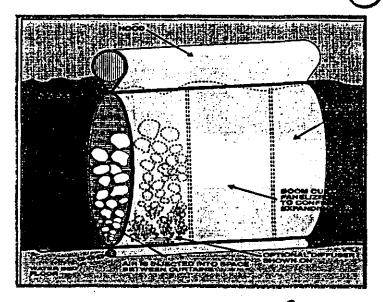
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What factors affect the design of a GUNDERBOOM® MLES™?

Each GUNDERBOOM® MLES™ is custom designed to account for factors including:

- > Target species and life stages.
- > Facility water flow rates.
- Physical factors, including bathymetry, bottom conditions, configuration of the water body and facility layout.
- Water body characteristics, including elevation changes, currents, wind-induced wave action and suspended sediment concentrations.
- > Seasonality of the problem and duration of deployment.
- > Degree of automation.



What are the filtering properties; how effective is a GUNDERBOOM² $MLES^{m}$?

The GUNDERBOOM® fabric is manufactured as a natting of minute fibers and, as such, has no designated opening size. The Apparent Opening Size (AOS), as determined by sieve analysis, is appoximately 20 microns. The GUNDERBOOM® material utilized for the MLE5™ barrier curtain is custom designed and modified for the target species and life stages. Since GUNDERBOOM® systems are also used for control of particulates as small as 0.2mm, fish eggs on the order of 1mm are easily controlled.

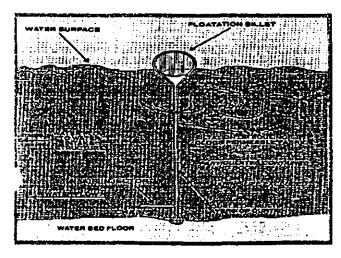
Gunderboom engineers and scientists carefully analyze the aquatic life to be excluded and balance the exclusion requirements with the modification to the filter fabric to produce optimum flow rates at the individual

facilities. The GUNDERBOOM® MLES™ has been demonstrated to reduce entrainments by at least 80% and is anticipated to produce unto 100% exclusion for many applications.

The GUNDERBOOM MLES* has been demonstrated to reduce entrainments by at least 80% and is anticipated to produce up to 100%

exclusion for many applications.

What data are available to evaluate GUNDERBOOM® Systems' Performance?



Since 1986, GUNDERBOOM® systems have been utilized for a number of particulate-control applications, including stormwater control, dredging, and surface drinking water supply protection, in addition to the MLES™ application. Data for the MLES™ has been acquired for a generating station on the Hudson River over a 4-year-development program, and is available in various annual reports. In addition to the field results, information is available from the lab tests, bench-scale programs, and flow modeling that has been accomplished during this same period of time. Data from a recent test to ensure that fish eggs or larvae are not adversely affected by contact with or operating GUNDERBOOM® MLES™ will be available in late 1999. Usi worst-case conditions, the study confirmed that boom impingemendoes not sigificantly affect survival.



dow is a GUNDERBOOM® deployed?

Initial deployment of the MLES— requires careful, advance planning. The anchoring array, whether conventional anchors or piling, is installed prior to the deployment of the barrier curtain. The "Air-Burst" Technology components, including the air supply and automated/computerized controls, are also installed in advance of the boom deployment. The GUNDERBOOM is delivered to the deployment site folded and stockpiled on a large pallet. Flotation billets are stacked on pallets next to the blanket-like boom, and when ready to deploy, are inserted by hand into precut access slits in the boom's top hood.

There are strong forces acting on the boom once it is set in place that derive from the head differential caused by the intake flow. These forces can be amplified significantly if the facility location is subject to strong current flow, winds, or wave action. The boom structure and anchoring array are designed for these factors and installation process carefully adjusted for the excessive loading.

When the initial portions of the installation are complete, the boom is towed to the location with the barrier curtain "reefed" up to the flotation hood. This reduces the load on the boom while it is being positioned in place. Once in position with temporary

moorings, divers attach the permanent mooring lines to the anchor array. Personnel on the shore bring the boom ends up onto the embankment or make attachments to fixed bulkheads, depending on the facility configuration. Final adjustments are made to ensure the correct positioning of the boom and then, when the currents and weather are favorable, the barrier curtain is systematically released, allowing the material to settle down to the bottom. The barrier curtain will immediately start to take shape and seal itself into the contoured configuration determined in the design phase. Once the curtain is sealed, the mooring lines are checked for balanced tension, divers inspect the underwater portions of the system and the "Air-Burst" Technology is operated in a start-up mode. The overall system is then monitored for a measured period of time and adjustments are made to the computer program, as necessary, to coordinate cleaning with current direction, siltation rates and other outside influences that may affect the boom's performance.

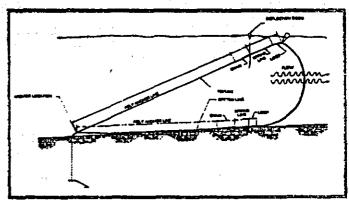
MLESTM boom deployments, once the anchoring and "Air-Burst" Technology are installed, can be accomplished within 2-3 weeks, barring problems with logistics and/or weather.

What kind of flow will an MLES™ System handle?

Gunderboom begins its' design for the MLESTM with a target of boom dimensions that will achieve filtration at a rate of appoximately 3-5 gpm per square foot of submerged fabric. This yields an average flow-through velocity of ~0.02 fps. System tests have shown that flow rates higher than 1C-12 gpm per square foot tend to exceed the material's optimum performance range.

The system is designed and operated to maintain the lower flow rates, which also contribute to limit any effects of impingement on the boom.

Applications that do not require elimination of fish egg entrainment and are targeted at larger organisims may allow for greater filter fabric alternatives and higher flow rates.



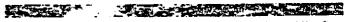
Typical MLES™ Cross Section While Operating

What about maintenance and durability?

Performance monitoring and regular maintenance are critical elements of a successful GUNDERSOOM installation. Gunderboom can work with facility operators, environmental staff, and company consultants to develop the optimum program that matches the operatoral considerations of the facility.

Gunderboom has made significant MLES^m design approvements in each of the four years since the first deployment, improvements in flow rate characteristics, material strength, automation of the cleaning system, and overall upgrading of the initial engineering/design process provide for a comprehensive

system that effectively manages entrainment issues for multiple years. This is accomplished with routine exchange and replacement of operational portions of the system and properly structured-maintenance programs.



"Your Gurdenboom has already proved itself, at the time we needed it most! Your fine work, and the improvements it provides to this state make Alaska a better place to live.

You centainly have that can-do spirit we admire so much.

Walter J. Hickel, Governor - State of Alaska - November 3, 1993"

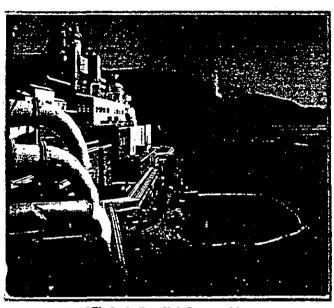


GUNDERBOOM, INC.

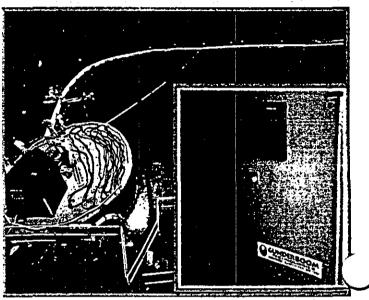
What are GUNDERBOOM® MLES™ options?

- > Boom Hood Material & Color.
- > Anchoring Systems, Piling or Fixed Structure Mounts.
- ➤ Manual or Computer-Controlled "Air-Burst"™ Technology.
- > Bird Deterrent System
- > Purchase vs. Lease

Gunderboom can work with facility operators, environmental staff, and company consultants to develop the optimum system solution that is compatible with operational needs of the water system



MLES™ Excluding Fish Eggs and Larvae from 46,000 GPM Intake



Installation of "Air-Burst"TM Technology — Computerized
Automated Cleaning System

How do I obtain more information about GUNDERBOOM Systems?

For more information on GUNDERSCOM® filter barrier solutions, SEE OUR WEBSITE at way sungerpass or contact us:



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^{*}Gunderboom systems are protected by Patents and Patents that are pending. The systems and designations — GUNDERBOOM * Marine/Aquatic Life Exclusion System-MLESTM; Central Sewer Overflow System — CSOSTM; Contaminated Particulate Control System — CPCSTM; Beach Protection System — BPSTM; Aquaculture Protection System — APSTM; Particulate Control System — PCSTM and "Air Burst" Technology and Reservoir Protection System — RPSTM are Registered Trademarks of Gunderboom, Inc. (Rev.1, 11/15/99)

GUNDERBOOM, TNG

System Specification

RP5TM



GUNDERBOOM® Reservoir Protection System

FOR PROTECTION OF SURFACE WATER SUPPLIES

Introduction

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Introduction

What is a GUNDERBOOM® RPS™#

What factors affect the design of a GUNDER-BOOM® RPS™?

What are the filtering properties, and `effective is a GUNDERBOOM®
RPS™?

What information is available evaluating the performance of GUNDERBOOM® Systems?

How is a GUNDERBOOM® deployed?

What kind of flow will an RPSTM System handle?

What about maintenance and durability?

What are GUNDERBOOM® RPS™ options?

How do I obtain more information about GUNDERBOOM® systems? GUNDERBOOM® manufactures, installs and maintains custom-designed Reservoir Aratection Systems™ (RPS™) to prevent the migration of particulates and their associated contaminants and pathogenic microbes within a surface drinking water supply system. The RPS™ can be used to address an individual problem or situation or may be incorporated as part of an overall strategy to manage and protect surface drinking water supplies.

The RPS™ is one specialized application of the GUNDERBOOM® Particulate Control Systems (PCS™).

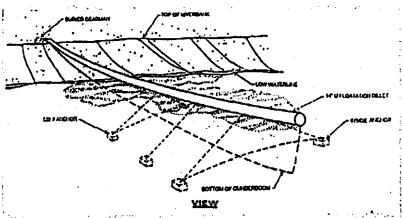
The RPS can be used to address an individual problem or situation, or may be incorporated as part of an overall strategy to manage and protect surface drinking water supplies. Gunderboom can provide the system, from design through annual maintenance, as a purchase and with a maintenance contract or under a long-term lease agreement

What is a GUNDERBOOM® RPS™?

A GUNDERBOOM® RPS[™] is a patented® full-water-depth filter curtain comprised of treated polypropylene/polyester fabric suspended by flotation billets on the water's surface and secured in place with anchoring systems.

Systems are custom designed and deployed to prevent the migration of particulates and associated pathogenic micro-organisms and other contaminants. For example: A system may be developed to prevent particulates and contaminants derived from storm water or from construction or

maintenance activities from migrating into a reservoir. Alternately, a system could be deployed to fully enclose a water-system intake and protect the intake from particulates and contaminants from sources within the reservoir.



AR001518



What factors affect the design of a GUNDERBOOM® RP5™?

Each GUNDERBOOM® RPS $^{\text{tm}}$ is custom designed to account for factors including:

- Nature and degree of the contamination problem and concentrations of suspended solids.
- Amount of flow from a source such as a storm-water outfall or into a water-system intake.
- Physical factors, including bathymetry, bottom conditions, and configuration of the water body.
- Water body characteristics, including reservoir elevation changes, currents and wind-induced wave action.



What are the filtering properties, and how effective is a GUNDERBOOM® RPS™?

Most GUNDERBOOM® filter fabrics are manufactured as a matting of minute fibers and as such, have no designed opening size. For one fabric, the Apparent Opening size (AOS) as determined by sieve analysis is approximately 20 microns.

The GUNDERBOOM® RP5™ has been found to be effective in reducing turbidity, suspended solids, and fecal and total coliforms. Based on data from paired samples taken inside and outside of the boom, statistically significant reductions have been observed for all parameters. Highest apparent differences observed in paired samples were on the order of 80-99% (or from 5-to 100:1) for turbidity: 99% (>25:1) for TS5; and for coliforms, on the order of 63-to-99% (2.5-100:1).

Representative values from a GUNDERBOOM® drinkingwater reservoir application in early 1999, where the PCS enclosed a cove that received a high volume of stormwater flow, were:

	Cove Side	Reservoir Side
TSS (mg/L)	9.9	0.7
Turbidity (NTU)	20.0	1.0
Coliforms (MPN)	>2400	22.0

What information is available evaluating the performance of GUNDERBOOM® Systems?

Gunderboom is conducting a project to provide bench-scale testing as well as a full-scale system performance evaluation. The project is being funded by the U.S. Environmental Protection Agency, National Risk Management Laboratory, Office of Research and Development. Data from this program will provide more specific data on filtering capacity than has been achieved through ambient water measurements to date. Preliminary data will be available in the latter half of 1999.

GUNDERBOOM^a systems have been utilized for a number of particulate-control applications, including storm water control, maintenance dredging, dredging for removal of contaminated sediments and bathing beach protection from high counts of coliform and flotables, along with surface drinking water supply protection. For a number of the applications, performance data have been acquired by RPS³⁰ purchasers. Inderboom has contracted to have an independent evaluation ade of the performance data that are available for a number of these applications. The Performance Evaluations are available to prospective clients and regulators upon request. These include:

- Port of Olympia , Pilot Dredging Project, Creasate Contaminated Soils
- Kensico Reservoir, Storm Water, Bacteria & Sediment Control
- Sea Cliff Beach, Bathing Beach Protection Bacteria & Flotable Control
- Manaroneck Village Beach, Bathing Beach Protection, Bacteria & flotable Control
- Gardiners Creek, Storm Water Control, Bacterial & Flotable Control

Page 3

How is a GUNDERBOOM® deployed?

Deployment is simple, usually requiring several people, a small vessel, and level surface near the water (i.e. beach, dock, etc.). The GUNDERBOOM® is delivered to the deployment site folded and stockpiled on a large pallet. Floating units are stacked on pallets next to the blanket-like boom and, when ready to deploy, are inserted by hand into precut access slits in the boom's top hood. Hoses and valves for the "Air-Burst" technology are connected as well.

Once in the water, the GUNDERBOOM is towed into position. Anchors are deployed at predesigned locations, generally to help retain the boom's shape. For a typical installation, the two primary anchoring points are at either end of the boom. Because the boom is flexible, it will cling to the shoreline-submerged terrain, providing a near-impenetrable seal against material transfer. Most boom deployments can be accomplished within two-ta-three days, barring problems with logistics and/or weather.



What kind of flow will an RPS™ System handle?

For reduction of particulates at such concentrations as are normally found in storm water, Gunderboom begins its design with a target of boom dimensions that will achieve filtration at a rate of approximately 1-3 gpm per square foot of submerged fabric. Depending on the anticipated concentrations of particulates and coliform levels and degree of control required, the design criteria might move toward either higher or lower flow-through rates.

The GUNDERBOOM® can be designed to span great distances in single-piece construction. It is capable of withstanding climate extremes and abuse, and it takes a minimum of manpower and equipment to accomplish

deployment

Many long-term
GUNDERBOOM

deployments have been at locations with extreme tide, wave and current forces acting on them

What about maintenance and durability?

In general, there is limited maintenance required for a GUNDERBOOM⁸ system deployed in a freshwater lake or reservoir environment. The boom has not shown a propensity to foul or become clogged where there is limited flow-through and the material tends to be non-biofouling. Natural motion of the boom tends to slough off any sediment buildup. Gunderboom has developed a double-fabric-layer RPSTM with an "Air Burst" Technology Cleaning System not is recommended for long-term applications where sediment volume may be high and where boom movements may be expected to be low. This double-layer, "Air-Burst" Technology Cleaning System was developed for a continuous-

high-flow application in the silt-laden Hudson River and found to be effective in maintaining flow even under those rigorous conditions.

Many long-term GUNDERBOOM* deployments have been at locations with extreme tide, wave and current forces acting on them. Even so, these applications have all had multi-year success. Gunderboom recommends that a formal inspection and maintenance program be implemented to ensure that the RP5TM is continuously and fully functional. Gunderboom will provide this service either as an adjunct to the sale of an installed system or as part of an annual system *lease arrangement.



What are GUNDERBOOM® RPS™ options?

- Boom Hood Material & Color.
- Double Layer System
- **Anchoring System**
- "Air-Burst" Technology Cleaning System
- Purchase vs. Lease.

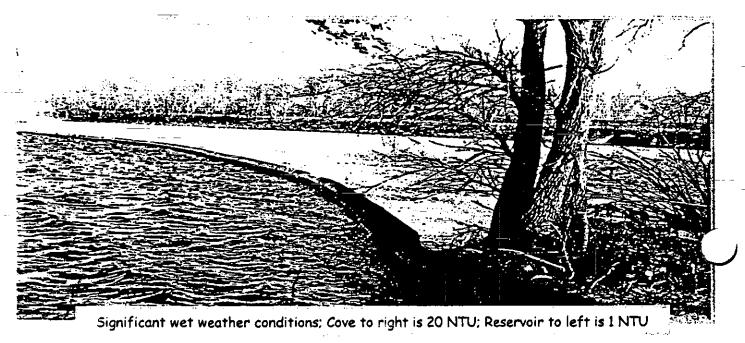
for more information on

GUNDERBOOM® filter barrier

solutions, SEE OUR WEBSITE at www.quncerboom.com or

contact us:

Gunderboom can work with facility operators, environmental staff, and company consultants to develop the optimum system solution that is compatible with operational needs of the water system



How do I obtain more information about GUNDERBOOM® Systems?

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1-907-344-5172 facsimile

gboom@micronet.net

Mailing Address: P.O. Box 222094

Anchorage, Alaska 99522-2094

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Arichorage, Alaska 9950:

East Coast

Eastern Sales and Operations

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1-207-767-0161 phore

1-207-767-4306 facsimile

gboom@mackworth.com

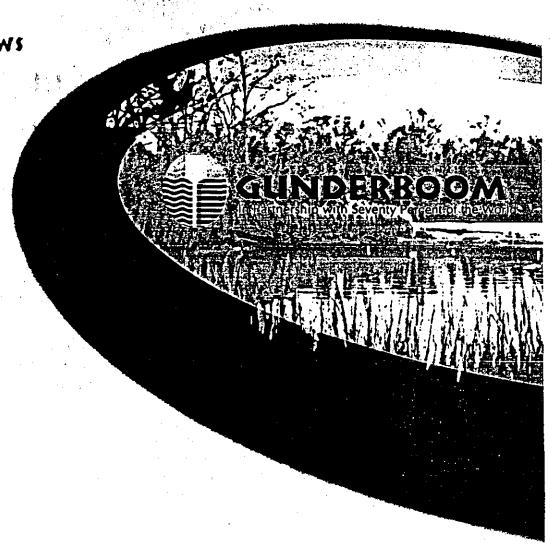
Offices of

Mackworth Environmental Maragement 3 Adams Street, Suite 316 South Portland, Maine 04106 www.mackworth.com

'Gunderboom systems are protected by Patents and Patents that are pending. The systems and designations - GUNDERBOOM * Marine/Aquatic Life Exclusion System-MLESTM; Central Sewer Overflow System - CSOSTM; Contaminated Particulate Control System - CPCSTM; Beach Protection System - BPSTM;

Aquaculture Protection System - APSTM; Particulate Control System - PCSTM and Air Burst"TM Technology and Reservoir Protection System - RPSTM are Registered Trademarks of Gunderboom, Inc. (Rev.1, 11/15/99)





GUNDERBOOM™ SYSTEMS

gun'dər-boom sis'-təm: an engineered solution that employs an aquatic filter-barrier to prevent the passage of particulates, particulate-associated pathogens/contaminates, "floatables", and/or floating or swimming organisms away from a source, into a water intake, or toward a special resource to be protected.



BIRTH OF THE GUNDERBOOM 5 (PC5")

Prevention of migration of particulates from dredging operations.



RESERVOIR PROTECTION SYSTEM (RPS*)

Protection of surface drinking water supplies by the control of particulates and coliforms.



CONTAMINATED PARTICLE CONTROL SYSTEM (CPCS")

Prevention of migration of pollutants associated with soil clean-up or removal in or adjacent to aquatic systems.



MARINE LIFE EXCLUSION SYSTEM (MLES")

Exclusion of fish eggs and larvae and other aquatic organisms to prevent entrainment and impingement in industrial cooling water intakes.



BEACH PROTECTION SYSTEM (BPS")

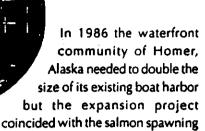
Protection of bathing heach areas from storm water-derived particulates and associated pathogenic microbes, "floatables", and jellyfish, fish and waterborne debris



GUNDERBOOM 3 FUTURE AND HIGHLIGHT EVENTS
International update...

PCS™ BIRTH OF THE BOOM

Innovation and Advancement are born out of a refusal to settle for the status quo



season. The large amounts of glacial silt and debris that would be released by dredging could impact the success of the salmon spawning and cause irreversible damage to water quality and bottom-living marine organisms near the project location in Kachemak Bay. Traditional "turbidity curtains" or booms were determined not to be adequate for the necessary containment.

Bill Gunderson, P.E.- VP and Senior partner of Peratrovich, Nottingham & Drage, the firm responsible for the design of the expansion project, undertook the design of a boom* that would both protect the invaluable natural resources in question and allow for the project to continue. Gunderson drew on his experiences as a fourth generation fisherman, lessons learned from the unforgiving Alaskan climate, and skills as a professional engineer to develop an acceptable solution. His answer was what has evolved into today's Gunderboom *Particulate Control System (PCSTM)* and its offspring boom systems.

"The differences between the Gunderboom and other in-water barriers are that the Gunderboom is an engineered, patented waterborne pollutant control system that filters water rather then just deflecting it," answers Bill when asked how this boom is distinguished from traditional methods. "We owe the success of the boom to development of the system by people experienced in marine construction, dredging, and

waterfront engineering design."

When the Exxon Valdez accident occurred in 1989, Bill was an integral part of the team mobilized to deal with the oil spill. Because of the size and the extent of the spill it was impossible to contain the oil in a localized area. So, a plan was needed to keep the oil from intruding into all the waterways connected with Prince William Sound. The Gunderboom system was utilized to successfully protect some of the critical salmon spawning streams and pristine glacier fjords from contamination. In the places it was deployed, the boom was able to prevent a tragic situation from becoming an even more

...Gunderboom is an engineered, patented waterborne pollutant control system that filters water rather then just deflecting it,

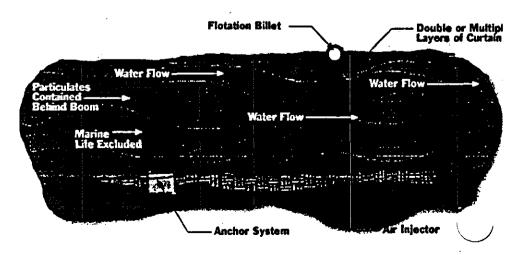
wide spread disaster. Alaskan Governor Wally Hickel personally commended Gunderson for his innovation and preservation efforts: "Your 'Gunderboom' has already proved itself, at the time we needed it most! Your fine work, and the improvements it provides to this state makes Alaska a place to live."

As the Gunderboom proved itself time and time again, the diverse uses of this technology became increasingly apparent. The Gunderboom was patented in 1992 and has continued to be improved upon in order to meet the specific needs in many of the following demanding settings and assignments.

*THE TYPKAL BOOM

The boom has come a long way since its first application in timber towns. Originally, the boom was a series of logs tied together to keep other logs from floating away while they awaited transport to the mills. Currently, the word "boom" refers to any number of pollutant and particulate control systems.

The Gunderboom systems consist of full water- depth curtains of polyester/polypropylene filtering materials suspended from flotation billets on the surface of the water.



MLES™ HUDSON RIVER, NY Giving the Fish a Fighting Chance



At times technology and the natural world are at odds with each other. Such was the case with the Orange and Rockland Utilities-Lovett Generating Station in New York.

The RiverKeeper of the Hudson River filed a lawsuit against the company because, in their opinion, the plant was not using the "best technology available" to prevent the entrainment (passage through the cooling water system, i.e., small organisms such as fish eggs or larvae) or the impingement (held by water pressure up against the screen grids protecting the cooling water system from entraining larger organisms or objects) of fish, fish larvae and other mobile invertebrate species.

Many generating plants are facing similar action or are currently in litigation due to their out-dated or inadequate marine life protection arrangements. As the search is made to be responsible stewards of our given resources the issue of cost becomes one of the looming lynch pins. Solutions that range in the tens of millions of dollars tend to slow the implementation of such endeavors.

So, in 1995, the O&R Utility contacted Gunderboom and began to investigate the potential application of Gunderboom's aquatic particulate control systems in reducing or eliminating entrainment by utilizing their considerably less costly and proven effective technology. After researching the unique environment of the Hudson River and the dynamics of the flow required by the plant, several hundred feet of Gunderboom's Marine Life Exclusion Sysytem (MLESTM) was designed, fabricated, and deployed to enclose one of the plant intake units. The test period allowed for a comparison of the entrainment numbers for the unit protected by the Gunderboom-MLES with those for a similar adjacent generating unit outside of the boom.

This project presented Gunderboom with some new challenges that led to further refinement and advancement of the Gunderboom technology. The large flow rate generated by the intake unit caused an unanticipated silt deposit to form rapidly on the outer surface of the boom the more the silt collected, the less effective the boom maintaining flow rates and marine life exclusion. As a count measure, Gunderson and his team developed the said system to clean each of the eight-foot sections of the continuous of air are forced through each panel to the accumulated silt or sediment. With this innovation was solved and the project was allowed to continuous.

That test ran for a month during high entrainment season. These first results gave a strong indication of the effectiveness of the system for eliminating entrainment. There was a dramatic reduction of 80-95% in the numbers of fish entrained because of the MLES, as compared with the entrainment outside the Gunderboom system.

As a result, a number of events have transpired that have been of great encouragement for all parties. Further refinements have been made in successive years to ensure the efficient and

There was a dramatic reduction of 80-95% in the numbers of fish entrained because of the MLES.

optimal operation of the Gunderboom system. Full computer-controlled automation of the Air-Burst TechnologyTM has been incorporated for the 1999 installation. Testing is underway to ensure that the boom does not have any adverse effects on 1852 eggs or larvae and preliminary results are affirmative. The ongoing success of the system has been documented in project reports and will soon be incorporated into a scientific paper.



RD5" WACHUSETT RESERVOIR, MA **EPA Funds Gunderboom Demonstration Project**

An ounce of prevention is worth a pound of cure...or perhaps millions of gallons per day, as is the case for many US surface water supply managers. In partnership with the United States Environmental

Protection Agency, the Massachusetts District Commission Office of Research and Development(MDC) and the Massachusetts Water Resources Authority(MWRA), made their Wachusett Reservoir available for a test of an innovative technology designed to protect the quality of surface water supplies. Like other water supply managers, MDC and MWRA are proactively protecting their drinking water supply for the Greater Boston area and much of Eastern MA. The water quality of the MDC system has been well within acceptable parameters and that is just the way they want to keep it.

The USEPA National Risk Management Labratory, office of Research and Development, selected Gunderboom as the company to conduct a bench-scale test and a full-scale demonstration project of a system to control storm-water derived

conaminanents entering the surface waters. A special apparatus has been designed and constructed for the bench-scale test and three separate storm events will be tested for this study.

The full-scale demonstration Gunderboom-Reservoir Protection System (RPSTM) was installed June 4, 1999. The system includes a 355' boom which closes off a cove fed by the Malagasco Brook. Beyond the cove, lies the Wachusett Reservoir. The system is designed to handle up to a 10,000 gal/min flow rate while reducing the particulates which carry bacteria and associated microbes/pathogens.

One of the innovative aspects of the project include a bird deterrent system. Frequently birds will treat the reservoir like they would a large beautiful lake but the defecation that accompanies their presence is an undesired by-product, in the case of a drinking water reservoir. In response, Gunderboom is testing the effectiveness of a new bird deterrent system.

The system was also designed to include the Air-Burst Technology™ for periodic cleaning that may be required. We will keep you up dated on the progress of this project in our next newsletter.



CDCS™ PORT OF OLYMPIA, WA Gunderboom Corners a Ghost

When it was time to consider a dredging and enlargement plan for the Port of Olympia, a ghost from the past came back to haunt the project. Many years

earlier there had been a creosote

factory that operated on the banks of the current port; and, there was a great deal of concern over the toxins that would be released as the sediment was removed and disturbed in the expansion process.

Although the conditions were different than the expansion of the Homer Boat Harbor, the technology employed there seemed to be well suited for the Port project. Gunderboom was asked to take on a small pilot project in the Port to test the dependability of the boom in this situation. After some fabric modifications for the full-length curtain and an adjustment to the hood flotation system the Gunderboom-Contaminated Particle Control System (CPCS™) was born.

Installed in 1998, the pilot program involved clam-shovel dredging of the Cascade Remediation site. According to Larry Beard, Principal for Landau Associates, the firm which supervised the project and tested the boom's performance: "The Gunderboom performed as promised, and it held back the suspended sediments and floating product that were created...we were impressed with the way the boom functioned to contain turbid water and how the anchoring system you designed helped hold the boom in position."

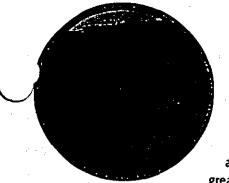
After the completion of this pilot program, Landau Associates wrote the following in the summary of their findings: "The Gunderboom containment system deployed for the marine dredging activities was effective in containing suspended sediment and non-aqueous phase liquid (NAPL) released during

"The Gunderboom performed as promised, ...we were impressed with the way the boom functioned to contain turbid water and how the anchoring system you designed helped hold the boom in position."

the dredging activities and represents an effective engineering control to protect water and sediment quality outside the dredging area." With the great success of the pilot program Gunderboom is now working on a full scale dredging containment for the expansion project in the Port of Olympia, scheduled for Fall 1999.

AR001525





SEA CLIFF, NY You Shouldn't Have to Wear a Biohazard Suit to the Beach

Imagine getting ready for a great day at the beach.
The kids are excited, you are excited- the weather is great and you have the whole day off to enjoy the waves and the

sand. You jump out of the car with your beach chair, cooler, and shades and race to your place in the sun. But when you reach the shoreline you are stopped in your tracks by a sign that says "Beach Closed-Unsafe Water Conditions."

Every summer all around the country and all around the world this has become a too familiar problem. Beaches are being closed on days when water tests show levels of bacteria too high to be safe or visible medical /industrial waste litters the shore and the swimming areas. Some of the most pristine stretches of sand have been rendered useless by these kinds of pollutants. Resorts, seaside businesses and community beach caretakers are all looking for answers to this dilemma.

Sea Cliff Village Beach in New York was one such community searching for a solution. In previous years they had been forced to close the beach on numerous occasions are to bacteria levels that exceeded (and at

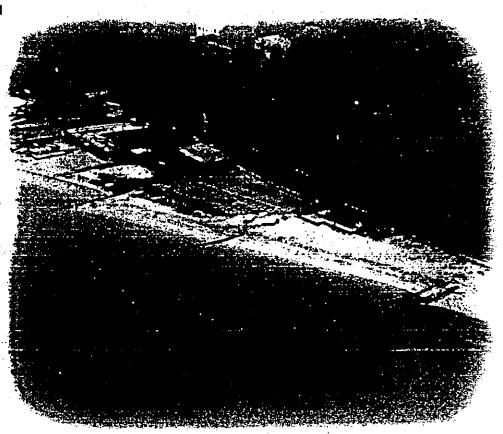
times far exceeded) the number of total coliforms considered safe (below 2400/100ml). Ray Bauer, a local business man, had observed the Gunderboom's exceptional performance while visiting an Alaskan dredging project and he decided to put the boom to test in his own backyard.

So the very first Gunderboom-Beach Protection System (BPS) was built and installed on a 31-day trial basis during the summer of 1990 at Sea Cliff. The full-length fabric curtain boom was extended around a portion of the beach to give a 100m x 50m swimming area. During the test period, the Nassau County Health Department was responsible

for the analysis of the water inside and outside the protected area. As expected, and much to the pleasure of the Sea Cliff community, the beach and the protected swimming area was able to be enjoyed without the usual and frequent closures. Meanwhile, the total coliform levels outside the system exceeded the safe levels on 8 of the 31 days (7 of these samples exceeded 5,000/100ml). The monitoring results of fecal and total coliform levels inside the BPS were an average of 60% lower than outside

The monitoring results of fecal and total coliform levels inside the BPS were an average of 60% lower than outside, over 90% lower after rainstorms...

and over 90% lower after rainstorms and larger run-off flows that typically increase hazardous swimming conditions. Collateral benefits included visibly, cleaner/clearer water, elimination of floating debris, and the passive exclusion of potentially dangerous marine life. The test proved to be a remarkable success for Gunderboom and the Sea Cliff Village Beach.





FUTURE AND HIGHLIGHT EVENTS

The number of inquiries for Gunderboom applications in the US and around the world has increased significantly during recent months as more data on system performance becomes available

and as more people become aware of the Gunderboom systems, their capabilities, and applications.

THIS PAST SPRING, GUNDERBOOM was invited to deliver a presentation at the Electrical Power Research Industry conference entitled, "Aquatic Impacts of Electrical Power Generation." The presentation was well received and generated much discussion. A written paper will be included in the Conference's Proceedings, which will be issued later in 1999. In Kansas City, during late June, Gunderboom was introduced as a new environmental technology at the 24th Annual Conference of the National Association of Environmental Professionals. Additionally, Gunderboom is cooperating with engineers of the Westchester Joint Water Works to prepare a paper for presentation on the Gunderboom system's effectiveness in improving waters of the Kensico Reservoir in NY.

GUNDERBOOM IS ACQUIRING valuable data through its contract with the USEPA National Risk Management Laboratory, Office of Research and Development. The benchscale test system developed for this project will help to refine design parameters for optimum flow rates for different application. The bench-scale system will also be utilized to run pilot tests on waters and sediments for potential Gunderboom application sites for which such data might benefit the work of Gunderboom design engineers. The Gunderboom RPS™ demonstration system in the Wachusett Reservoir in central Massachusetts has been designed and deployed with

special sampling ports to better characterize water qua parameters "pre- and post-filtering" by the Gunderboom system.

GUNDERBOOM, INC. HAS BEEN CONTACTED

by the Environmental Protection Agency Region I in Boston. Massachusetts, to co-operate in determining the potential effectiveness of Gunderboom systems to help the Charles River Initiative achieve its goal of "fishable/swimmable" by Earth Day 2005. Preliminary assessments indicate that the Gunderboom BPS™ will control the suspended solids and pathogenic microorganisms effectively. For "swimmable" waters in Massachusetts, there is criteria of "clarity" that requires 4 feet vertical visibility. The final question is the degree to which clarity in the Charles is affected by dissolved organics, such as tannins from decay of vegetative material (leaves, primarily). The EPA, US Geological Survey and Gunderboom are in discussions to determine appropriate testing in order to evaluate Gunderboom's potential effectiveness for resolving and maintaining clarity standards throughout the swimming season.

The full extent of the Gunderboom's application in conservation and pollution control situations has ample opportunity for expansion. In many cases the Gundert may be exactly what a company needs in order to contine operation under compliance with state or federal regulations while it works on longer-term water quality solutions.

INTERNATIONAL UPDATE...

The National Hydraulics Research Institute of Malaysia (NAHRIM) has chosen Gunderboom for two projects; first it will be used as wave reduction system during mangrove reforestation work. Secondly the Gunderboom will be used as a sediment and aquatic organism barrier during construction of the world's largest reclamation project.

For more information on GUNDERBOOM® systems or to discuss your particular application, contact us:

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GUNDERBOOM® Marine/Aquatic Life Exclusion System

FOR EXCLUSION OF PLANKTONIC EGGS AND LARVAE AND SWIMMING ORGANISMS FROM ENTRAINMENT IN COOLING WATER SYSTEM INTAKES

Introduction



Inside:

Introduction/Description

Design/Filtering

Performance Evaluation 2

Deployment 3

Flaw Rate

Maintenance/Durability 3

Options

Our Lecations 4

Gunderboom designs, engineers, manufactures, installs, and maintains Marine Life Exclusion Systems (MLESTM) to prevent the entrainment and impingement of ichthyoplankton and juvenile aquatic life at intake structures.

Gunderboom has manufactured and installed systems for control of particulates and the protection of marine and aquatic life since 1986. The MLESth has been under development since 1995 when the first version was installed at a power-generation plant on the Hudson River in New York. For this project, Gunderboom engineers were engaged by the utility to develop new and more sophisticated technology to prevent the entrainment of planktonic fish eggs and larvae.

The system is now available to minimize or eliminate entrainment impacts, to respond to discharge requirements and to commence developing provisions of the Clean Water Act, Section 3168. The

installation of a MLESTM also eliminates or significantly reduces the entrainment and impingement of finfish and mobile invertebrate species. The MLESTM can be used to address an individual problem or situation, or may be incorporated as part of an overall strategy to manage 3168 compliance issues.

GUNDERBOOM® applications include:

Construction Debris Containment

Dredging Silt Containment

Oll Spill Containment

Texic Perticle Containment

Underwater Blasting Protection

Hetchery & Wildlife Pretection

Water Supply Protection

Biological Organism Exclusion In

livers, Streams, Pands, Beaches, etc.

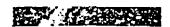
What is a GUNDERBOOM® MLES™?

A GUNDERBOOM® MLES™ is a patented* full-water-depth filter curtain comprised of treated polypropylene/polyester fabric suspended by floatation billets on the water's surface and secured in place with anchoring systems. These systems can also be installed with pilings or other structured support. The MLES™ system consists of the following component parts:

- Polyvinyl reinforced hood with flotation billets sized to meet enticipated load requirements.
- > Polypropylane maoring lines at top and bettom.
- Double panel barrier curtain of GUNDERSOOM® material, modified for flow requirements.
- Structural reinforcement strops, grammats and attachment points.
- > Ballast chain in bottom sleeve.
- Automated and computerized "Air-Burst" Technology Curtain-Cleaning System.

Anchoring system errory designed to carry intended leads designed for the geophysical constraints of the facility.

GUNDERBOOM® systems are custom designed and deployed to provide for the passage of large volumes of water while excluding particulates. In the MLES™ application, the target particulates are planktonic and neustonic aganisms. The system is designed and installed to completely surround the intake structure, away from the shoreline. With the GUNDERBOOM® fully sealed against the seafloor and shoreline structures, all water passes through the fabric at a lower velocity, thus providing positive filtration of all water entering the facility's intake systems. Boom-curtain material is designed and fabricated so it will fit the contour of the bottom configuration surrounding the facility. The design process also addresses the interfaces with the facilities fixed structures at each end of the boom system.

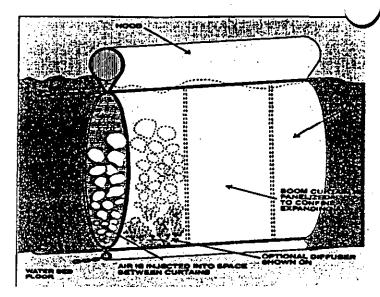


Page 2

What factors affect the design of a GUNDERBOOM® MLES™?

Each GUNDERBOOM® MLES™ is custom designed to account for factors including:

- > Target species and life stages.
- > Facility water flow rates.
- Physical factors, including bathymetry, bottom conditions, configuration of the water body and facility layout.
- Water body characteristics, including elevation changes, currents, wind-induced wave action, and suspended sediment concentrations.
- > Seasonality of the problem and duration of deployment.
- Degree of automation.



What are the filtering properties, and how effective is a GUNDERBOOM[®] $MLES^{m}$?

The GUNDERBOOM® fabric is manufactured as a matting of minute fibers and, as such, has no designated opening size. The Apparent Opening Size (AOS), as letermined by sieve analysis, is appoximately 20 microns. The GUNDERBOOM® material utilized for the MLES™ barrier curtain is custom designed and modified for the target species and life stages. Since GUNDERBOOM® Systems are also used for control of particulates as small as 0.2mm, fish eggs on the order of 1mm are easily controlled.

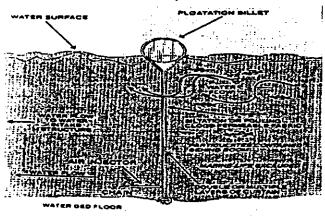
Gunderboom engineers and scientists carefully analyze the aquatic life to be excluded and balance the exclusion requirements with the modification to the filter fabric to produce optimum flow rates at the individual

facilities. The GUNDERBOOM® MLES™ has been demonstrated to reduce entrainments by at least 80% and is anticipated to produce up to 100% exclusion for many applications.

The GUNDERBOOM® MLES™ has been demonstrated to reduce entrainments by at least 80% and is anticipated to produce up to 100%

exclusion for many applications.

What information is available to evaluate the performance of GUNDERBOOM® Systems?



Since 1986, GUNDERBOOM® systems have been utilized for a number of particulate-control applications, including stormwater control, dredging, and surface drinking water supply protection, in addition to the MLES™ application. Data for the MLES™ has been acquired for a generating station on the Hudson River over a 4-year-development program, and is available in various annual reports. In addition to the field results, information is available from the lab tests, bench-scale programs, and flow modeling that has been accomplished during this same period of time. Data from a recent test to ensure that fish eggs or larvae are not adversely affected by contact with an operating GUNDERBOOM® MLES™ will be available in late 1999. Using worst-case conditions, the study confirmed that boom impingeme does not sigificantly affect survival.



Page 3

How is a GUNDERBOOM deployed?

E726 95 1

Initial deployment of the MLES[®] requires careful, advance planning. The anchoring array, whether conventional anchors or piling, is installed prior to the deployment of the barrier curtain. The "Air-Burst^{om} Technology components, including the air supply and automated/computerized controls, are also installed in advance of the boom deployment. The GUNDERBOOM® is delivered to the deployment site folded and stockpiled on a large pallet. Flotation billets are stacked on pallets next to the blanket-like boom, and when ready to deploy, are inserted by hand into precut access slits in the boom's top hood.

There are strong forces acting on the boom once it is set in place that derive from the head differential caused by the intake flow. These forces can be amplified significantly if the facility location is subject to strong current flow, winds, or wave action. The boom structure and anchoring array are designed for these factors and installation process carefully adjusted for the excessive loading.

When the initial portions of the installation are complete, the boom is towed to the location with the barrier curtain "reefed" up to the flotation hood. This reduces the load on the boom while it is being positioned in place. Once in position with temporary moorings, divers attach the permanent mooring lines to the anchorarray. Personnel on the shore bring the boom ends up onto the

embankment or make attachments to fixed bulkheads, depending on the facility configuration. Final adjustments are made to ensure the correct positioning of the boom and then, when the currents and weather are favorable, the barrier curtain is systematically released, allowing the material to settle down to the bottom. The barrier curtain will immediately start to take shape and seal itself into the contoured configuration determined in the design phase. Once the curtain is sealed, the mooring lines are checked for balanced tension, divers inspect the underwater portions of the system and the "Air-Burstam" Technology is operated in a start-up mode. The overall system is then monitored for a measured period of time and adjustments are made to the computer program, as necessary, to coordinate cleaning with current direction, siltation rates and other outside influences that may affect the boom's performance.

MLESTM boom deployments, once the anchoring and "Air-Burst^{TTM} Technology are installed, can be accomplished within 2-3 weeks, barring problems with logistics and/or weather.

What kind of flow will an MLES™ System handle?

Gunderboom begins its' design for the MLESTM with a target of boom dimensions that will achieve filtration at a rate of appoximately 3-5 gpm per square foot of submerged fabric. This yields an average flow-through velocity of ~0.02 fps. System tests have shown that flow rates higher than 10-12 gpm per square foot tend to exceed the material's optimum performance range.

The system is designed and operated to maintain the lower flow rates, which also contribute to limit any effects of impingement on the boom.

Applications that do not require elimination of fish egg entrainment and are targeted at larger organisims may allow for greater filter fabric alternatives and higher flow rates.

One of the
GUNDERBOOM® primary
benefits is its ability to
meet any depth
requirement

What about maintenance and durability?

Performance monitoring and regular maintenance are critical elements of a successful GUNDERBOOM® installation. Gunderboom can work with facility operators, environmental staff, and company consultants to develop the optimum program that matches the operational considerations of the facility.

Gunderboom has made significant MLESTM design mprovements in each of the four years since the first deployment. Improvements in flow rate characteristics, material strength, automation of the cleaning system, and overall upgrading of the initial engineering/design process provide for a comprehensive

system that effectively manages entrainment issues for multiple years. This is accomplished with routine exchange and replacement of operational portions of the system and properly structured-maintenance programs.



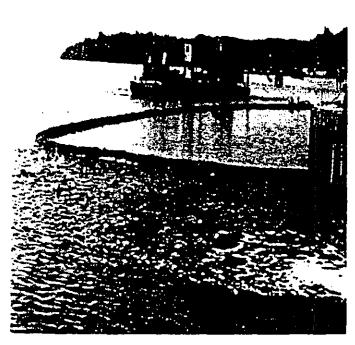
GUNDERBOOM, INC.

What are GUNDERBOOM® MLES™ options?

- > Boom Hood Material & Color.
- > Anchoring Systems, Piling or Fixed Structure Mounts.
- > Manual or Computer-Controlled "Air-Burst" Technology.
- > Bird Deterrent System
- > Purchase vs. Lease

Dell' All Marie Control

Gunderboom can work with facility operators, environmental staff, and company consultants to develop the optimum system solution that is compatible with operational needs of the water system.





How do I obtain more information about GUNDERBOOM® Systems?

For more information on GUNDERBOOM® filter barrier solutions, SEE OUR WEBSITE at www.qunderboom.com or contact us:

West Coast

Corporate Offices and Western Operations

H.B. (Hal) Dreyer

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1-907-344-5172 facsimile

gboom@micronet.net

Mailing Address: P.O. Box 222094

Anchorage, Alaska 99522-2094

Shipping: 400 L Street, Anchorage, AK 99501

East Coast

Sales and Eastern Operations

Andrew J. (Andy) McCusker

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gboom@mackworth.com

Offices of
Mackwarth Environmental Management
3 Adams Street, Suite 316
South Partland, Maine 04106
www.mackworth.com

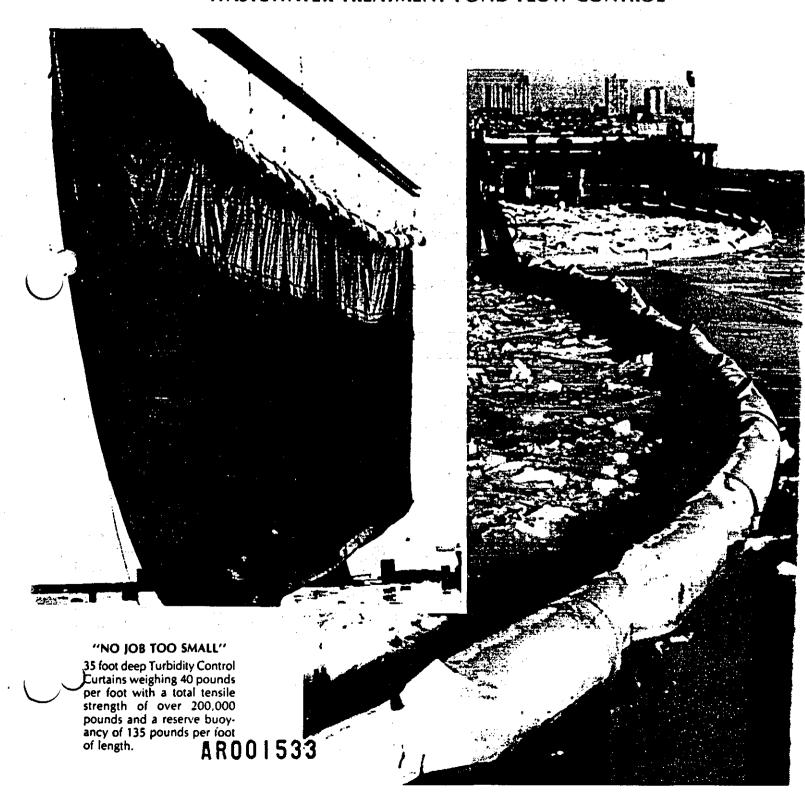
^{*}Gunderboom systems are protected by Patents and Patents that are pending. The systems and designations – GUNDERBOOM * Ma rine/Aquatic Life Exclusion System-MLESTM; Central Sewer Overflow System – CSOSTM; Contaminated Particulate Control System – CPCSTM; Beach Protection System – BPSTM; A quaculture Protection System – APSTM; Particulate Control System – PCSTM and "Air Burst" Technology and Reservoir Protection System – RPSTM are Registered Trademarks of Gunderboom. Inc.

VENDOR INFORMATION

Turbidity Curtains - American Marine

AMERICAN MARINE FLOATING BAFFLES, CURTAINS & NETS

- MARINE CONSTRUCTION POLLUTANT CONTROL
- FLOATING DEBRIS CONTAINMENT
- WASTEWATER TREATMENT POND FLOW CONTROL





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➤ www.elastec.com

PAST PERFORMANCE HISTORY

- 1. PROJECT NAME: River Rasin Remediation Project
- 2. STAGING LOCATIONS: Monroe, MI
- 3. CUSTOMER: Ford Motor Co.
- 4. DATES OF PERFORMANCE: June 1997 to September, 1997
- 5. SIMILARITY TO SERVICES REQUIRED: This project demonstrates Elastoc/American Marine's ability to design, manufacture and maintain a turbidity control curtain system to the satisfaction of U.S. B.P.A. and other government agencies tasked with oversite of a contaminated remediation project.
- 6. PRIME CONTRACTOR OR SUBCONTRACTED WORK: Subcontract to Luedtke Engineering Co.
- REVELANT SERVICES PROVIDED: Elactec/American Marine's unique design and adjustable skirt system demonstrate our ability to design and manufacture new technology systems.

During the duration of this project the curtain system performed as expected experiencing no failures or escape or contaminated material from the work area.

Post-It° Fax Note 7671	Octo 123 99 pages 12
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Caropplant Crowser	ca. Ami
Phone 391-985-8100	Phone 407-636-5783
Ful 201- 985- 8182	Fax 6 407-636-5787



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➤ E-Mail: ami4018ao..com

PAST PERFORMANCE HISTORY

- 1. PROJECT NAME: Grass River Remediation Project
- 2. STAGING LOCATIONS: Massena, NY
- 3. CONTRACT NUMBER: 30DS1100
- 4. CUSTOMER: Alcoa Aluminum
- 5. DATES OF PERFORMANCE: June, 1995 to September, 1995
- SIMILARITY TO SERVICES REQUIRED: This project demonstrates Elastec/American
 Marine's ability to design, manufacture and maintain a trubidity control curtain system to the
 satisfaction of U.S. E.P.A. and other government agencies tasked with oversite of a
 contaminated remediation project.
- 7. PRIME CONTRACTOR OR SUBCONTRACTED WORK: Subcontract to OHM
- 8. <u>REVELANT SERVICES PROVIDED</u>: Elastec/American Marine's unique design and adjustable skirt system demonstrate our ability to design and manufacture new technology systems.

During the duration of this project the curtain system performed as expected experiencing no failures or escape or contaminated material from the work area.

Silt Curtains Assist In Contaminated Sediment Removal

American Marine i sili curiains installed on the shore of the Grasse River. New York.



loating turbidity control curtains have been used since 1970 to pended silts general

control suspended silts general ed, by dredging and marine construction operations.

Their use is intended to guard against adverse environmental impact to the area adjacent to the work site

Recently, silt curtains have been found to be useful during hazardous material or contaminated sediment removal operations in a marine environment. The following case history summarizes one project which utilized silt curtains.

In 1995, after months of evaluation, a permit was assued to remove PCB laden sediments from a river in the vicinity of an industrial complex's water discharge in upstate New York.

The remediation project was headed by OHM Corporation. It involved the participation of Federal, State and Local agencies, engineers of the company and subcontractors, including American Marine, Inc.

The remediation plan involved

underwater surveys, which revealed the location of many large boulders in the contaminated area which would have to be removed.

The plan proposed the use of state-of-the-art dredging techniques which were designed to keep disturbance and suspension of the sediments to a minimum.

A multi-stage sediment treatment process was to be set up on the owners property to "clean" the removed sediments. All of these processes had been granted a green light early on.

At issue was the need to isolate the work area from the rest of the river to insure that no resuspended sediments created during dredging would spread downstream

The obvious plan was to employ silt control curtains to encircle the work area and control the release of any sediments which would find their way to uncontaminated areas downstream.

State and Federal agencies were skeptical about the effectiveness of silt control curtains prior to this project.

(Continued on Pg. 20)



LWT Automated Solids Control dredges sweep lagoons without supervision. Enter the flow rate and solids density in the Programmable Logic Controller – LWT Automated Rail Lateral Move & Bottom Sense" systems then regulate flow and solids content. Cuts dewatering polymer use and improves process system efficiency. Proven in municipal and supertund installations.

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Silt Curtains Assist In Contaminated Sediment Removal

(Continued from Pg. 16)

Curtains were attempted forda similar project on the St. Lawrence Seaway. A combination of improper installation, current and vessel traffic rendered the curtain useless.

The silt curtain task for this new project was given to American Marine. They were to design a viable curtain and installation plan which would be effective. The silt curtains were proposed and the installation was approved and permits were issued.

American Marine installed a xystem consisting of three silt curtains. two of which were parallel to one another approximately 10 feet apart. They formed the outer perimeter of the work area.

The Inner and Outer curtains, as they were labeled, incorporated a reefing system which allowed workers to keep the curtain bottoms within prescribed distances off the bottom of the river.

The curtains were arranged in a semi-circle starting well upstream of the dredging area where they were anchored to the river bank.

They were then deployed into the river, side by side, at a alight angle to the current so that they sended to deflect the river water flow. This orientation of the curtains to the normal flow of the river greatly reduced any tendency of the Now to overload the curtains or raise their ballast chains.

The third curtain was utilized inside the two perimeter curtains to locally isolate the immediate area in which the dredge was operating.

American Marine personnel were present and handled all curtain installation, movement and removal during the project.

The curtains were delivered and installed by American Marine in June 1995. They remained in place until the end of dredging operations in September.

The silt curtains performed their nurpose successfully. Despite dredging techniques designed to limit sediment resuspension, turbio which is up to 200 m wide in places. ity levels inside the curtains were nigh.

The state of the s

Constant monitoring outside the curtains revealed no unacceptable release of sediments. The American Marine Silt Control Curtains had performed as expected. The result was a renewed acceptance of silt curtains as an effective tool to isolate a contaminated sediment removal.

It was proven that with sufficient site-specific information, a determination can be made if silt curtains will be viable.

Secondly, if the curtains are designed properly and manufactured to strict quality standards, the remediation contractor can rely on their performance.

And finally, if a well planned installation scheme is employed. then silt curtains will be effective.

(Article submitted by American Marine. Inc., Cocoa. Florida.)

Dredeco Applies New Technology To Brisbane Airport

(Continued from Pg. 19)

Due to width restrictions (down to 20 m) in this area, the small cutter suction dredge Mudsnapper has been utilized

The third and final phase calls for main dredging of the Floodway by the cutter 500 mm suction dredge Bilba. Completion of the entire project is scheduled for March 1997.

The Bilba has undergone major modifications for the scheme. The 20-week program of work has been under way at Dredeco's yard in Brisbane. The dredge has been lengthened to achieve optimum productivity by reducing the number of cuts needed to cover the width of the Floodway.

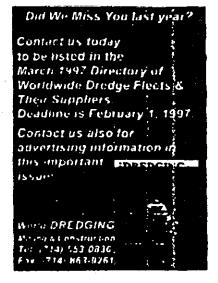
in order to obtain an optimum "swing" of 75 m, the Bilbu has been lengthened by 12 m

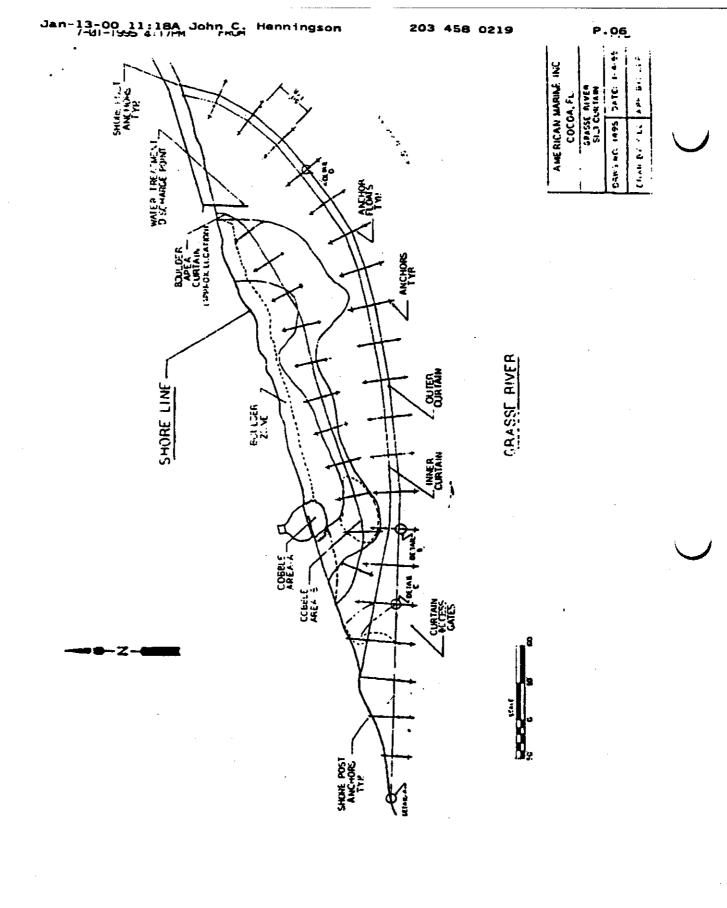
In addition, this dredge has been fitted with the latest environmental dredging technology . Dredging international's new Sweephead. The Sweephead was developed for high productivity and accuracy when dredging thin layers. It also offers very low turbidity and spillage.

The Brisbane Floodway contract marks the first deployment of the Sweephead beyond Europe. This follows encouraging results during demanding trials of the new technology at the heavily polluted Ketelmeer Lake in the Netherlands.

Dredeco offered this latest environmental dredging technology to meet the ultra low turbidity constraints required by the client. Despite the substantial modification program, the completion time of the entire project was not compromised IN ARY WAY.

The Sweepdredge option proved attractive for the Floodway assignment. Dredeco's project team planned not only to meet the tough turbidity and accuracy parameters but also to exceed the production rates of a conventional cutterhead dredge, 🛈







UNION CARBIDE CORPORATION ENGINEERING PROJECTS

ENGINEERING PROJECTS SEADRIFT PLANT Port Lance, TX 77979 Part GIQ \$15-3265

May 31, 1995

American Marine, Inc. PO Box 940 Cocces, Fierida 22922 Attn: Ilm Fearce

Subject: Cooling Water Basin Bastles

Dear Mr. Pearce,

I would like to take this opportunity to thank American Marine for the outstanding efforts that were exhibited by your company to meet our secret send for six large floating baffles. Not only did you seed your delivery commitments, you best them by several weeks. This, in-turn, has allowed us to scorlerate the installation schedule as well. Five of the six baffler are installed, with the last scheduled for completion by week's end. This improvement is overall schedule will undoubtedly increase production as we enter the hot summer months. This is good news to Union Carbide's profits, as sales of most of our products is high.

Your personal responsiveness and accidence during design, fabrication, and delivery were of great value, and appreciated. You "welked the extra mile", or should I say, "drove the extra thousand miles" to deliver the first load of baffics yourself. This is indeed automar focus at it's finest.

This is the second opportunity that I have had to week with your company, and look forward to weeking with you again, should UCC have battle or boost needs in the future. I wish all suppliess were as value and customer conscience as you.

Sincerely,

R.C.Pilener, Project Engineer

CC: W.S.Diefenbach, Mans Furchering D.D.Darrah, General Project Manager S.L. Orsak, Unit Representative I.M.Astoyo, Project Manager L.G.Boyer, Group Manager

> Butt Valley Reservoir, CA (415-973-3493) September 1996

Monroe, Mi (Ford Plant) (616-352-9631) July 1996



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> Tel: 407.636.5783 Fax: 407.636.5787

➤ E-Mail: ami401@aol.com

RUFFWATERSCREEN SPECIFICATIONS

DESCRIPTION:

This product consists of an impervious skirt with floatation members enclosed in a top pocket, a pair of load carrying cables below the flotation and a ballast chain enclosed in a bottom pocket.

SECTION LENGTH:

Normally 50 to 100 feet but adjustable by special order to any length.

DRAFT:

Any depths from 3 feet to 30 feet (or more by special order).

FREEBOARD:

11 to 12 inches.

FLOTATION ELEMENT:

Normally 12" x 7' octagonal expanded polystyrene "logs" placed end to end in the top fabric pocket with separations between "logs" to allow folding for shipment and storage.

FABRIC:

Normally, 22 ounce per square yard vinyl coated nylon

or polyester.

Base Fabric Tongue Tear Trapezoid Tear Grab Tensile Strip Tensile

6 ounce per yard nylon or polyester
150/150 pounds

- 100/80 pounds - 500/400 pounds - 400/300 pounds - 10 pounds per inch

Hydrostatic Resistance

- -40°F

TENSION CABLES:

Adhesion

2 each 5/16 inch vinyl coated galvanized steel cables, one on each side of the skirt 20 inches below the flotation. These cables are secured to each end connector of the curtain section and clipped together with lap links and grommets every 30 inches.

BALLAST:

Ballast is provided by 3/2 inch, or heavier, galvanized steel chain enclosed in a bottom pocket of the skirt.

This pocket is double walled to provide more abrasion resistance for the bottom of the ballast chain pocket.

SECTION CONNECTORS:

Sections of Ruffwaterscreen are joined by sliding together the two halves of the aluminum Universeal connectors that extend from the top of the flotation down to the tension cables. Below the connectors the skirts are joined by rope ties between grommets on the the two skirts. The ballast chains may be shackled together to make the joint complete from top to bottom. No tools are required for joining sections.

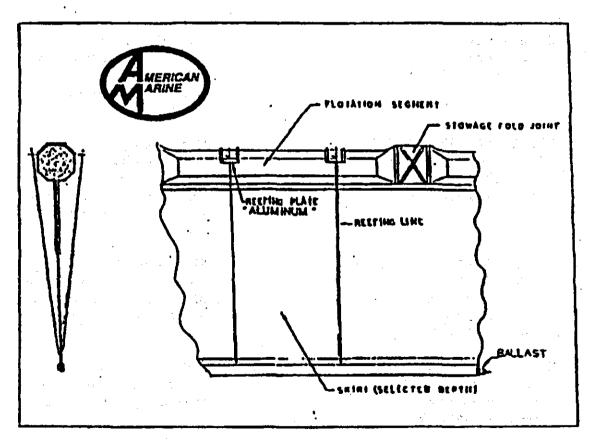


AMERICAN MARINE, INC.

Subject: Baffle Reefing System-

This system is designed to allow the depth of the baffle skirt to be adjusted up or down as needed. Each flotation log segment is equipped with lines which run from the flotation collar down to the bottom of the skirt and back up the opposite side of the baffle to the flotation collar. There are two lines per flotation log. Each end of the line passes through a hole in an aluminum saddle which straddles the float and conforms to its octagonal shape. The lines are then knotted or looped so they cannot pass back through the saddle. By pulling these lines the skirt of the baffle is lifted to the desired depth. Likewise, a reefed skirt can be lowered to a desired depth by lowering the lines. The skirt is held at the desired depth by tying the lines together at the saddle. (See attached drawing)

This is a proven design that has been successfully deployed in a number of applications where skirt depth adjustments were required. Recently this system is in use on a curtain located on the River Raisin in Monroe, Michigan. The customer is Ford Motor Company.



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Turbidity Control & Custom Curtain Projects

Customer References (Partial)

CUSTOMER

CITY OF NEW YORK

Department of Sanitation New York, NY

Contact: Evelyn Reis Telephone: 212-788-3730

CHEMUNG CONTRACTING

Elmira, NY

Contact: Thomas Kinsman Telephone: 607-737-6200

PINE BLUFF SAND AND GRAVEL

Alexandria, LA

Contact: Mark LeMoine Telephone: 318-487-1731

VOLKER STEVIN PACIFIC

Kirkland, WA

Contact: Michael Hansen Telephone: 206-822-0344

FLORIDA POWER AND LIGHT CO.

West Palm Beach, FL Contact: John Hatfield Robert Peg

Telephone: 407-640-2283

HENNEPIN COUNTY PARKS AND RECREATION

Plymouth, MN

Contact: Timoth Marr Telephone: 612-559-9000

PROJECT

Staten Island, Fresh Kills, Marine Transfer Station. Floating Trash Boom and Nets Annual Contract since 1989.

Sharptown, MD
Standard Ruffwaterscreen
with 12 ft. 20 ft. skirts
Fast current installation.

Red River Locks, Conshatts, LA Fastwaterscreen installed after another manufacturer's failed. 600 linear feet, 10 ft. deep. Completed the job and was reusable.

Carnation, WA Tolt Reservoir Hydro Electric Project. Turbidity curtain with exact bottom contour, flow through windows. Made of FDA approved vinyl.

FLP Cooling Water Discharge Canal. Floating net for marine life exclusion. Average current 2.8 ft/sec. Net - 14 ft. deep.

Swim area Isolation Curtains.
Reefable curtains for isolating
and treating swim areas on lakes



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SILT CURTAINS

AMERICAN MARINE, INC. QUALITY AND SERVICE 401 SHEARER BLVD. COCOA, FLORIDA 32922

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WEB PAGE: www.elastec.com E-MAIL: AMI401@AOL.COM



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This document is distributed by American Marine, Inc. to provide familiarization with silt control curtains and their good and bad points. It is intended to provide basic information to marine construction planners and on-site supervision regarding the selection, installation, maintenance, repair and storage of silt control curtains.



APPLICATION AND PERFORMANCE OF SILT CURTAINS

1. GENERAL DESCRIPTION

One method for physically controlling the dispersion of near surface turbid water in the vicinity of open-water pipeline disposal operations, effluent discharges from upland containment areas, and possibly small (clamshell) dredging operation in quiescent environments involves placing a silt curtain or turbidity barrier either downstream or around the operation. Silt curtains (Fig. 1) are impervious, vertical barriers that extend from the water surface to specified water depth. The flexible, polyester reinforced vinyl fabric forming the barrier is maintained in a vertical position by flotation material at the top and a ballast chain along the bottom. A tension cable is often built into the curtain immediately above or just below the flotation segments (top tension) to absorb stresses imposed by currents and other hydrodynamic forces. The curtains are usually manufactured in 100 ft. sections that can be joined together at a particular site to provide a curtain of specified length. Anchored lines hold the curtain in a deployed configuration that is usually U-shaped or circular.

Silt curtain effectiveness, defined as the degree of turbidity reduction outside the curtain relative to the turbidity levels inside the curtain enclosure, depends on several factors such as the nature of the operation; the quantity and type of materials in suspension within or upstream of the curtain; the characteristics, construction, and condition of the silt curtain, as well as the area and configuration of the curtain enclosure; the method of mooring; and the hydrodynamic conditions (i.e., currents, tides, waves, etc.) present at the site. Because of the high degree of variability in these factors, the effectiveness of different silt curtain operations is consequently highly variable. It should be emphasized here that silt curtains cannot effectively be used around every conceivable dredging or disposal operation; they are not recommended for operations in the open ocean, in currents exceeding 1 kt, in areas frequently exposed to high winds and large breaking waves, or around hopper or cutterhead dredges where frequent curtain movement would be necessary.



2. PROCESSES EFFECTING SILT CURTAIN PERFORMANCE

In many cases where silt curtains are used the concentration of fine-grained suspended solids inside the curtain enclosure may be relatively high (i.e., in excess of 1/g) of the suspended material may be composed of relatively large, rapidly settling flocs. In the case of a typical pipeline disposal operation surrounded by a silt curtain (Fig. 2) where suspended solid concentrations are high and material usually flocculated, the vast majority (95 percent) of the fine-grained material descends rapidly to the bottom where it forms a fluid mud layer that slopes away from the source of material at an approximate gradient of 1:200. The other 5 percent of the material remains suspended in the water column above the fluid mud layer and is responsible for the turbid appearance of the water inside the curtain. While the curtain provides an enclosure where some of the fine-grained material may flocculate and/or settle, most of this fine-grained suspended material in the water column escapes with the flow of water and fluid mud under the curtain. The silt curtain does not indefinitely contain turbid water but instead controls the dispersion of turbid water by diverting the flow under the curtain, thereby minimizing the turbidity in the water column outside the silt curtain.

Whereas properly deployed and maintained silt curtains can effectively control the flow of turbid water, they are not designed to contain or control fluid mud. In fact, when the accumulation of fluid mud reaches the depth of the ballast chain along the lower edge of the skirt, the curtain must be moved away from the discharge; otherwise sediment accumulation on the lower edge of the skirt will pull the curtain underwater and eventually bury it. Consequently, the rate of fluid mud accumulation relative to changes in water depth due to tides must be considered during a silt curtain operation.

3. SILT CURTAIN EFFECTIVENESS

In some cases where relatively quiescent current conditions (0.2 ft/sec or less) are present, turbidity levels (measured in terms of NTU's or mg/1) in the water column outside the curtain can be 80 to 90 percent lower than the levels inside or upstream of the curtain. While there may be a turbid layer flowing under the curtain, the amount of suspended material in the upper part of the water column, as a whole, is substantially reduced. However, the effectiveness of silt



curtains can be significantly reduced in high energy regimes characterized by currents and turbulence. High currents cause silt curtains to flair, thus reducing the curtain's effective depth; in fact, in a current of 1 kt the effective skirt depth of a 5-ft curtain is approximately 3 ft.

Increased water turbulence around the curtain also tends to resuspend the fluid mud layer and may cause the turbid layer flowing under the curtain to resurface just beyond the curtain.

However, even under moderate currents (up to 0.5 kt), a properly deployed and maintained center tension curtain can effectively control the flow of turbid water (under the curtain). In other cases, where anchoring is inadequate and particularly at sites where tidal currents dominate the hydrodynamic regime and may cause resuspension of the fluid mud as the curtain sweeps back and forth (over the fluid mud) with changes in the direction of the current, the turbidity levels outside the curtain can be as much as 10 times higher than the levels inside the curtain. With respect to overall effectiveness and deployment considerations a current velocity of approximately 1.5 ft/sec appears to be a practical limiting condition for silt curtain use.

4. GUIDELINES FOR SELECTING AND USING SILT CURTAINS

A. <u>SITE SURVEY:</u> Prior to specifying or selecting a curtain for a particular project, it is necessary to characterize the deployment site with respect to current velocity, water depth (relative to tidal range), bottom sediment types, and possibly background levels of turbidity. Since silt curtains are only marginally effective at current velocities in excess of 1 kt, maximum surface currents over a tidal cycle (12 or 24 hours) should be established first. Current velocities can be estimated by determining the time that it takes for a block of wood to float downstream a specified distance; velocity is equal to distance divided by time. In addition, information on current direction and water turbulence may also indicate potential deployment problems and/or the best configuration(s) to use.

If hydrodynamic regime appears to be conducive to silt curtain deployment (i.e., current velocities are less than 1 kt), a survey of the water depths over the entire site and surrounding areas is required so that a curtain with a proper skirt depth can be selected and its initial and future placement geometries determined. At the sites where



the tidal range (i.e., the difference in depth between high and low tide) is negligible, a simple bathymetric survey can be performed preferably with a vessel equipped with a precision navigation system and a fathometer. However, if tidal prediction tables (or curves) indicate that the tidal range exceeds approximately 1 ft over a tidal cycle, the survey data must be adjusted to account for these changes in the water depth that will occur during the silt curtain operation. These minimum depths at the lowest low tide are then used to determine necessary skirt depth allowing 1 or 2 ft of clearance between the lower edge of the skirt and the existing bottom in the disposal area at the lowest low tide during the operation. The effect of fluid mud accumulation on water depth as well as the proposed schedule for moving the silt curtain to prevent burial should also be considered in selecting the curtain skirt depth.

In addition to evaluating the current conditions and water depths, the character of the bottom sediment/vegetation at the proposed deployment site should also be established using a grab sampler or a coring device, to determine the type of anchors to use. Convenient anchor points on the outer limits of the deployment site should also be noted. The potential effect of boat traffic and boat generated waves on the proposed deployment configuration and mooring system should also be considered. Since launching and retrieving the silt curtain will undoubtedly involve the use of a large truck and a boat(s), a launching ramp, crane services, etc., should be located as near the site as possible. If an evaluation of silt curtain effectiveness relative to pre-operation on background conditions is desired, background turbidity levels must be determined preferably under a variety of current and wave conditions. Samples may be taken with a conventional water sampler at the surface, mid-depth, and near the bottom.

B. <u>DEPLOYMENT CONFIGURATIONS</u>. After the deployment site has been surveyed, the geometry of the deployed curtain should be determined based on the type of silt curtain application, the hydrodynamic regime at the deployment site, and such factors as boat traffic. Any environmental policies regulating allowable turbidity levels as a function of distance from the operation should also be considered. Some typical deployment geometries are shown in Fig. 3.



In some cases, the curtain may be deployed in an open-water environment in the form of a "maze", a semi-circle or U, or a circle or elipse. The maze configuration ("A", Fig. 3) has been used on rivers where boat traffic is present, but appears to be relatively ineffective due to direct flow through the aperture between the curtain sections. On a river where the current does not reverse, a U configuration ("B", Fig. 3) is acceptable, but the distance between the anchored ends of the curtain (i.e., across the gap) should be large enough to prevent leakage of turbid water around the ends of the U. Where the turbid water is being generated by effluent from a containment area or a pipeline disposal operation close to the shoreline the curtain can be anchored in a semi-circular or U configuration ("C", Fig. 3) with the ends of the curtain anchored onshore approximately equidistant form the discharge point. The required radius of the configuration is determined by the type and volume of material being disposed inside the curtained area as well as the water depth. (Procedures for calculating the necessary radius and/or schedule for moving the curtain to prevent burial are given in Fig. 8). In a tidal situation with reversing currents a circular of elliptical configuration ("D", Fig. 3) is necessary. Unfortunately, this latter case requires a more extensive mooring system. Typical curtain might be 500 to 1500 ft for the U or semi-circular configurations; 1000 to 3000 ft for the circular/elliptical case.

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C. <u>SILT CURTAIN SPECIFICATIONS</u>. The silt curtain can now be selected based on the appropriate deployment geometry and the characteristics of the deployment site. From an evaluation of silt curtain performance under varying field conditions, it is recommended that silt curtains have a skirt depth such that the lower edge is 1 to 2 ft off the bottom at low water; however, the skirt depth should not exceed 10 ft unless the current velocities at the site are negligible. The fabric should be a reinforced PVC material (or equivalent) with a minimum tensile strength of 300 lb/in.; a minimum fabric weight of 13 oz/sq yd for very low current conditions, 22 oz/sq yd for higher current conditions; a tear strength of 80 lbs or 200 lbs for 13 oz or 22 oz fabric, respectively; and a tensile strength after abrasion of greater the 200 lb/in. The fabric surface should be easy cleaning and resistant to marine growth, ultraviolet light, and mildew. All fabric seams



should be heat sealed. Sections of solid, closed-cell, plastic foam flotation material should be sealed into a fabric pocket and provide a buoyancy ration (bouyant force/curtain weight) of greater than 5. Each flotation section should have a maximum length of less than 10 ft so the curtain may be easily folded for storage or transport. In low current situations (where velocities are less than 0.1 kt) most available connectors for joining 100 ft sections probably maintain adequate physical contact along the entire skirt joint. If current velocities exceed 0.1 kts aluminum extrusion (or an equivalent) load transfer connectors are recommended (Fig. 4). The non-corrosive, ballast chain should have a weight ranging from approximately 1 lb/in ft for a 5 ft skirt depth up to 2 lb/in ft for a 10 ft skirt depth. When current velocities are negligible, no tension member (other than the fabric itself) is necessary. For current velocities between 0.1 and 1.0 kt, a galvanized or stainless steel wire rope should be used as a top or center tension member; the center tension curtain provides a greater effective skirt depth, and strength, but requires more effective anchor systems. Repair kits are necessary for patching minor tears in the fabric.

5. TRANSPORTATION.

When transporting silt curtains from a storage facility to an unloading site, they should be furled (Fig. 5) tied with light straps or line evert 3 to 5 ft, compactly folded accordion style, packaged into large bundles, carefully lifted into the transport vehicles, and transported to the unloading site. At the unloading dock the curtain can be unloaded and maneuvered into the water by backing the truck down the ramp so that the tailgate is as close as possible to the water and then unloading the curtain by carefully pulling it out of the truck (like a string of sausages); the 100 ft sections are joined as they are payed out. After all the sections have been joined, the curtain can be towed to the site by boat at 2 to 3 kts. Curtains over 2000 ft long have been towed in this way. The curtain should always remain furled until it has been deployed at the operation site.

An alternative method involves maneuvering the curtain onto an open-decked work boat or barge, transporting it to the site, and finally offloading the curtain in sections. The sections are



then joined as the curtain is deployed.

6. MOORING.

Improper and/or inadequate mooring systems have historically contributed to silt curtain ineffectiveness and catastrophic failure. The recommended mooring system (Fig. 6) consists of an anchor, a chain, an anchor rope (line or cable), and mooring and crown buoys. It is recommended that the curtain be anchored from the section joints every 50 or 100 ft in a radial pattern (Fig.3) and on both sides if the curtain is exposed to reversing tidal currents. Half-inch polypropylene line used in conjunction with lightweight, self butying anchors with weights of at least 22 lbs for sandy bottom sediment and 50 lbs for mud will provide adequate holding power in most situations. However, with increasing current velocities, the anchor weights will also have to be increased.

After the furled curtain has been anchored, it should be checked to ensure that the skirt is not twisted around the flotation. If this is the case, the curtain should be separated at the nearest connector, untwisted, and rejoined. The curtain in its deployed, untwisted configuration can now be unfurled by simply cutting the furling lines or straps. If the barrier needs to be repositioned during the operation, any curtain with a long skirt depth relative to the ambient current conditions should be refurled before it is moved.

7. DEPLOYMENT MODEL.

The length of time that a silt curtain can remain deployed in its initial configuration before the enclose area must be enlarged or the curtain moved to a new location to prevent siltation along the lower edge of the curtain depends on the accumulation of fluid mud inside the curtain relative to the deployment geometry, the discharge rate, and the initial bottom gap (i.e., the distance between the lower skirt edge and the bottom sediment at the beginning of the operation) as shown in Fig. 7. Although the size of the enclosure is limited by the total length of the curtain available for the project, as the area of the enclosure increases, the length of time before the curtain must be moved also increases. In addition, as the gap between the lower skirt edge and the bottom sediment increases, the frequency of curtain movement decreases. Since it



may be necessary to move a silt curtain during an operation, and this involves manpower, the following procedure can be used to develop a general schedule for curtain movement and deployment.

To illustrate the use of the nomograph (Fig 8) used in this procedure, let us assume that approximately 3200 ft. of curtain with a skirt depth of 5 ft. surrounds an open-water pipeline disposal operation located in a quiescent environment with a water depth of 9 ft. The circular configuration has a radius of approximately 500 ft. The dredged material slurry with a solids content of 15 percent (by weight) is discharged from an 18-in. pipeline at a velocity of 18 ft/sec. To determine when the fluid mud dredged material will build up to the lower edge of the silt curtain:

- a. Enter graph I (upper left, Fig. 8) at "A" for a 500 ft radius.
- b. Proceed vertically to "B", the planned initial bottom gap (e.g., 4 ft) between the silt curtain and the existing bottom sediment.
- g. Move horizontally through the axis indicating the approximate volume of the fluid mud dredged material mound (e.g., 16 million cu ft) to "C" (graph II).
- d. Draw a vertical line from "C" through the axis indication the amount of a slurry pumped (20 million cu yd) and into graph IV.
- g. Enter graph III (lower left) at "D", the appropriate flow velocity (e.g., 18 ft/sec.).
- f. Proceed vertically to the curve indicating the appropriate pipeline diameter (e.g., 18 in.).
- g. Draw a horizontal line from "E" through the discharged rate axis (e.g., at 2.7 million cu ft/day) and into graph IV until it intersects the vertical "total volume of a slurry pumped" line at "F". The length of time (before the curtain needs to be moved) is estimated from the diagonal time line that goes through "F".

In this example the operation can probably continue for approximately 7 to 8 days before the curtain must be moved due to sediment buildup to the depth of the lower skirt edge. Fig. 9 shows that the mound will be approximately 6.5 ft thick under the discharge and will extend radically approximately 1300 ft. If the configuration were semicirular, the above procedure would be performed in the same manner (using the radius of the semicircle) and the derived time



divided in half. Similarly, if the curtain is deployed in a square configuration with sides of length L, assume that the curtain is circular or elliptical in shape with a radius of L/2.

As pointed out previously, this procedure can be used to calculate a very approximate schedule for moving silt curtains. Because of the varying characteristics of an operation (i.e., slurry density, pumping time, etc.) And the settling/consolidation characteristics of the fluid mud, there may be a great deal of variability associated with the rates of dredged material accumulation. However, this model does provide a conservative (i.e., a shorter length of time between curtain movements than might be necessary at an actual operation) time framework for planning the silt curtain operation. Additional data and experience should indicate the degree of accuracy of this methodology and possible modifications that might improve its usefulness.

8. MAINTENANCE.

To maximize the effectiveness of a silt curtain operation, maintenance is extremely important. This entails moving the curtain away from the turbidity source just before the fluid mud layer reaches the lower edge of the skirt, replacing worn or broken anchor lines, and maintaining the integrity of the curtain by repairing leaking connectors and/or tears in the curtain fabric. Tears in the flotation pocket can be repaired in the water with a hand type pop rivet gun. Moderate tears in the skirt may be repaired on land with a vinyl repair kit or a special heat gun. Because extensively torn sections must be returned to the manufacturer for immediate substitution in the field. Improper maintenance not only will decrease the curtain's effectiveness on a particular operation but also will increase the cost of reconditioning the curtain for reuse.

9. RECOVERY AND STORAGE.

After the operation has been completed, the curtain should be refurled, the anchor/mooring system recovered, and the curtain returned to the launching site for repacking and subsequent storage. If properly stored in a location that is unexposed to the elements, years and reused on a subsequent operations.



10. REMARKS.

The discussion above provides very general information and basic guidelines that should help in evaluating the feasibility of using silt curtains on a particular operation. Experience with their use is necessary to become really proficient in the selection, handling, relocation, maintenance, repair and storage of these devices.



LIST OF ILLUSTRATIONS

FIGURE TITLE 1. Center Tension Curtain 2. Process effecting the performance of Silt Curtains in controlling dredged material dispersion. 3. Typical Silt Curtain Deployments. Recommended Aluminum Extrusion Connector for joining Silt Curtain sections. Furling of the Curtain Skirt for deployment and/or recovery. Recommended Silt Curtain mooring system. Parameters effecting the schedule for moving 7. and redeploying Silt Curtains. Curtain relocation interval rate. 8. Dimensions of a fluid mud mound with a slope 9. of 1:200.

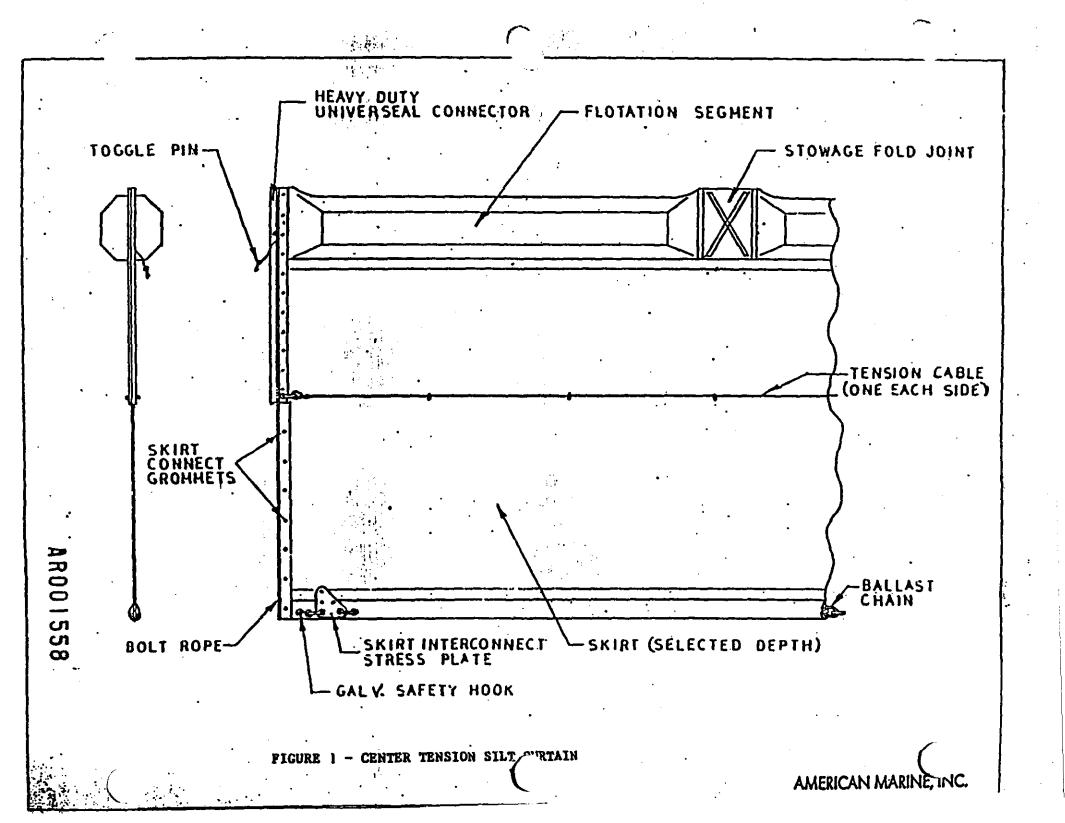


Figure 2 - Processes affecting the performance of silt curtain in controlling dredged material dispersion.

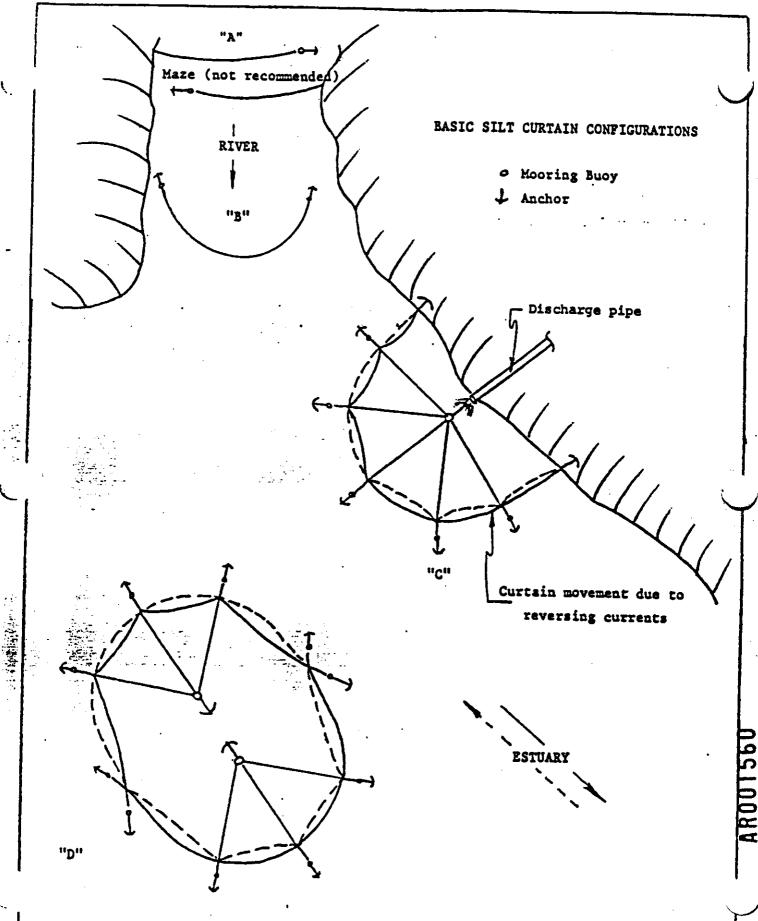


Figure 3 - Typical silt curtain deployment configuration.

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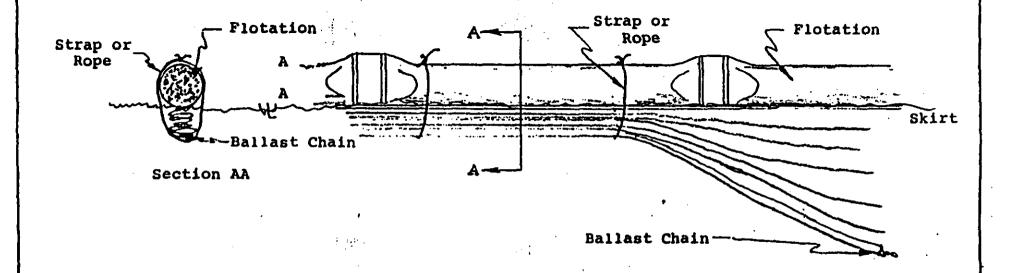
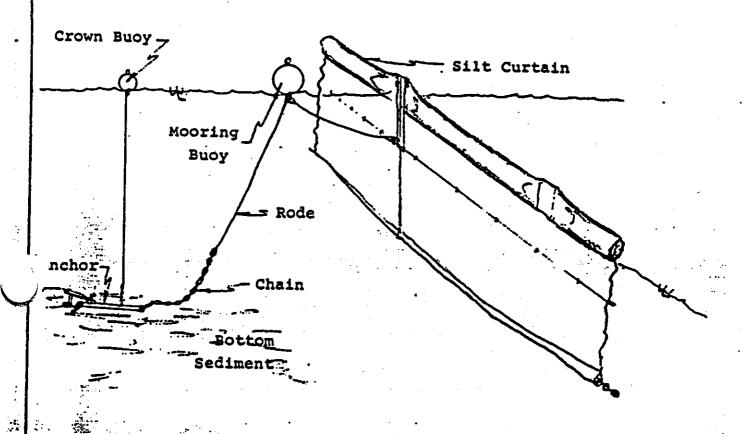


Figure 5 - Furling of the curtain skirt for deployment and/or recovery of silt curtains.



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Figure 6 - Recommended silt curtain mooring system.

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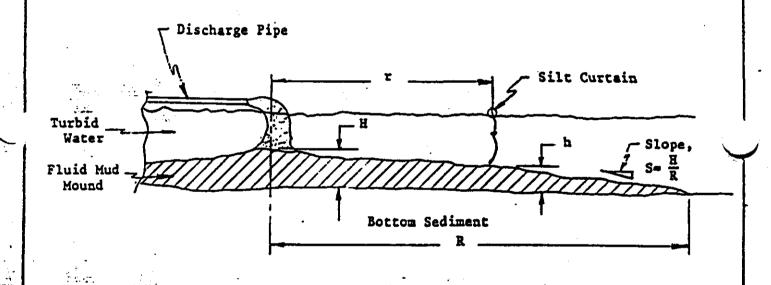
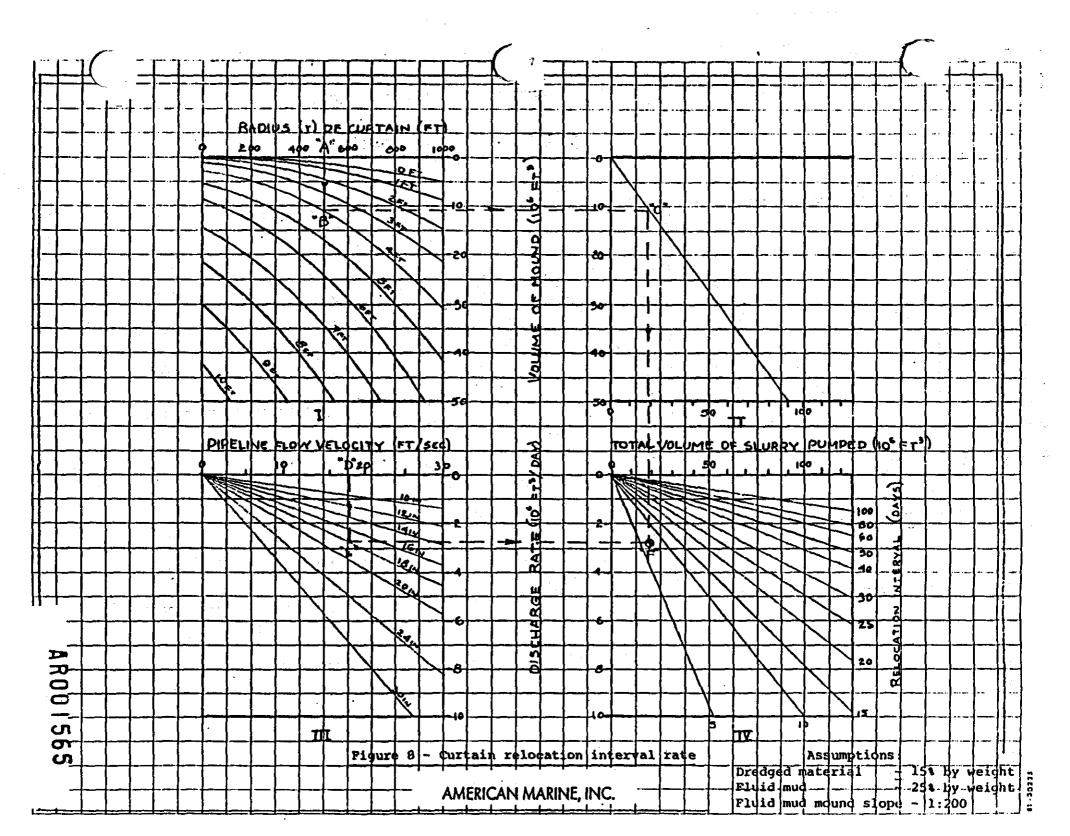
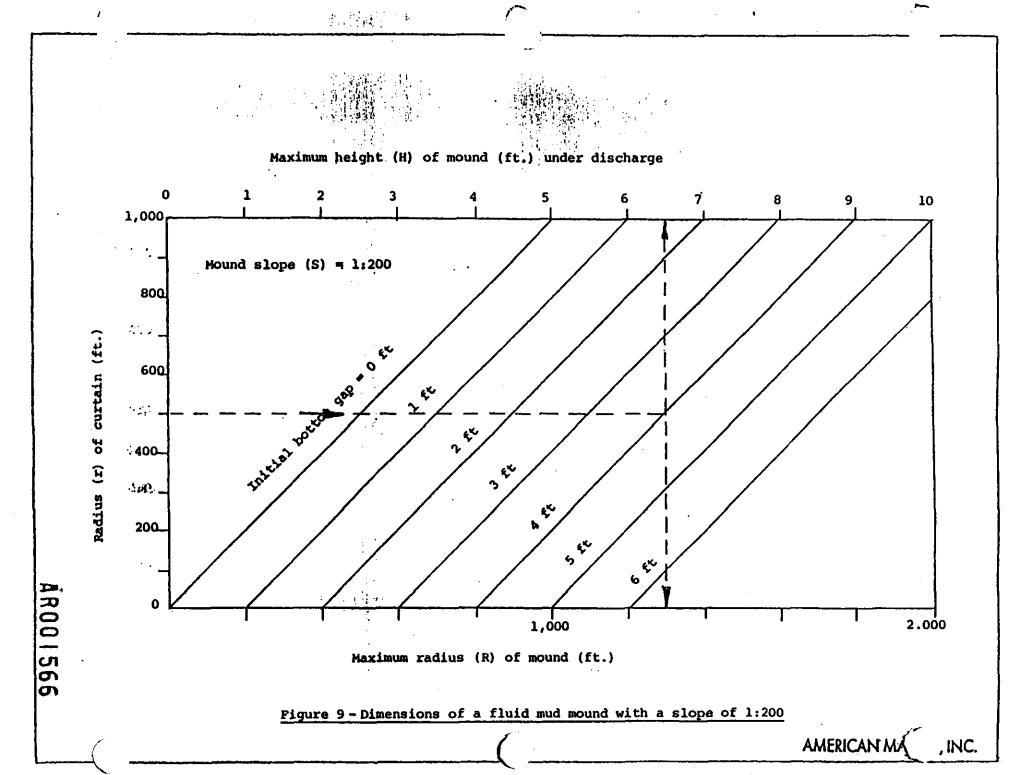


Figure 7 - Parameters affecting the schedule for moving and redeploying silt curtains.







AMERICAN MARINE TURBIDITY CONTROL CURTAIN SELECTION, INSTALLATION, REMOVAL AND MAINTENANCE

BARRIER SELECTION:

American Marine turbidity control curtain is fabricated in three styles to accommodate varying current and wind conditions.

TYPES OF CURTAIN:

<u>STILLWATERSCREEN</u> - is designed for use in protected waters where there is no current and the area is sheltered from wind and waves.

<u>FASTWATERSCREEN</u> - is designed for use in areas where there may be some small current running and/or wind and waves can effect the curtain.

<u>RUFFWATERSCREEN</u> - is designed for use in areas where considerable (1-2 knot) current may be present, where tidal action occurs and/or where the curtain is liable to be subject to wind and wave force.

<u>CURTAIN DEPTH</u>: Curtain depth selection depends upon the depth of the water, the type of bottom and the current prevailing in the area. The curtain should not be so long as to touch the bottom. If it does touch bottom, two unsatisfactory consequences may result:

(1) The skirt may become buried in the pump-in fill, sink the flotation and ultimately make it impossible to remove the curtain.



(2) Movement of the lower skirt over the bottom due to tidal reverses or due to wind or wave action on the flotation may fan and stir silt already settled out.



A rule of thumb pertaining to the proper depth of a silt curtain in still water is to keep it at least two feet above the bottom. In moving water the curtain acts more as a downward deflector of silt laden water and hence it may be more effective to employ two relatively shallow curtains, one behind the other than to attempt to settle the silt via the use of a single deep curtain. It must be remembered that a curtain cannot slow up or stop the flow of water and that very sizeable loads can be built up in a large curtain anchored in moving water. In moving water it is seldom practical to extend curtain depth below 10 to 12 feet below the surface even in deep water. Curtains deeper than this will be subject to very large loads with consequent strain on the material and the mooring systems. Furthermore, the curtain will billow up toward the surface under the pressure of the moving water which will result in an effective depth considerably less than the skirt depth, anyway.

CURTAIN INSTALLATION:

Every turbidity curtain installation has its own set of unique conditions to be considered during installation. In the calm water of lakes or ponds it is usually sufficient to merely set the curtain end anchor points or stakes, using anchor buoys when anchors are employed, then tow the curtain in the furled condition out and attach it to these anchor points or stakes. Following this, any additional buoyed anchors or stakes required to maintain the desired exact location of the curtain may be set and these anchor points made fast to the curtain. Only then the furling lines should be cut to let the curtain skirt drop.

In rivers or in other moving water installations it is important to set all the curtain anchor points, being sure they are of sufficient holding power to retain the curtain under the current conditions existing, before putting the furled curtain into the water. Again, anchor buoys should be employed on all anchors to prevent the current from submerging the flotation at the anchor points. If the moving water into which the curtain is being installed is tidal and will hence subject the curtain to currents in both directions as the tide changed, it is important to provide

anchors on both sides of the curtain for two reasons:

- (1) so curtain movement will be minimized during tidal current reversals and
- (2) so the curtain will not overrun the anchors and pull them out when the tide reverses.

When the anchors are secure the <u>furled</u> curtain should be secured to the upstream anchor point and then sequentially attached to each next downstream anchor point until the entire curtain is in position. At this point, and before unfurling, the "lay" of the curtain should be assessed and any necessary adjustments made to the anchors. Finally, when the location is ascertained to be as desired, the furling lines should be cut to allow the skirt to drop.

An effective way to employ a turbidity curtain in moving water is to locate it at less than 90 degrees to the current direction so as to provide a "deflector" along which the silt laden water will move dropping out its sediment in the desired area along one side of the curtain while the water on the other side is protected.

Turbidity curtain has also been used effectively in large areas of moving water by forming a very long sided, sharp "V" to deflect clean water around a work site and confine a large part of the silt laden water to the work area inside the "V" as it moves downstream with the sediment settling as it moves.

REMOVAL OF CURTAIN:

The most significant precaution to be observed in removing a turbidity curtain is to protect the skirt from damage as the curtain is dragged out of the water. If the curtain has a deep skirt it can be protected by running a small boat along its length with a crew installing furling lines before attempting to remove the curtain from the water. Also, the site (beach, ramp, etc.) Selected to tow the curtain ashore should be free of sharp rocks, broken cement, debris, etc. so as to minimize damage when hauling the curtain over the area.

CLEANING OF CURTAIN:

If the curtain has been in the water long enough to collect barnacles and other marine



growth, it should be cleaned immediately upon removal from the water. If allowed to dry out before cleaning, the barnacles and growth become considerably more difficult to remove and the chance of damaging the fabric during cleaning is increased. The curtain should be spread onto as flat and smooth a surface as possible for cleaning and the growth removed with a piece of wood or other object not likely to tear the vinyl. A stiff bristle brush may be used to remove most of the accumulation (except barnacles) and the curtain should then be rinsed off before being dried, furled and stowed for storage or re-use.

STORAGE OF CURTAIN:

When the curtain has been cleaned, rinsed and allowed to dry it should be "accordianed up", tied and covered to protect it from the sun.

REPAIRS:

Should repairs become necessary, American Marine, Inc. has repair kits. Clean the area to be repaired with acetone. Cut a patch larger than the damaged area. Apply glue, then put on the patch and roll vigorously with a bottle or can until dry. Approximately ten minutes is required to dry. Pop rivets and fender washers may also be used for repair jobs.



ANCHOR SYSTEMS FOR BOOMS AND BARRIERS

- 1) A 24 pound DANFORTH type galvanized steel anchor.
- 2) An 8 foot long 3/8 inch galvanized steel chain lower rode.
- 3) A 60 foot long 5/8 inch polypropolene rope upper rode.
- 4) A 12 inch diameter polypropolene painter.
- ** The anchor to chain rode attachment is by a safety wired galvanized steel shackle.
- ** The chain to rope rode connection is also by a safety wired galvanized steel shackle

 (All ropes have thimbled terminations.)
- ** The upper rode buoy painter attachment is via a loop of 5/16 inch galvanized steel wire rope.
- ** Attachment of the painter to the boom or barrier is by galvanized steel shackle.

APPENDIX 8

Response to USEPA Comments Dated February 22, 2000

APPENDIX 8

Comment Responses for Pre-Design Investigation Report USEPA Comments Dated February 22, 2000 Metal Bank Superfund Site

Ogden Environmental and Energy Services Co., Inc. (Ogden) and Hart Crowser (HC) have reviewed the comments to the Pre-Design Investigation (PDI) Report, which were provided by the USEPA (letter dated February 22, 2000). The comments have been incorporated into this Preliminary Design deliverable. In accordance with Ogden's discussions with Ms. Linda Dietz dated March 3, 2000, Ogden and Hart Crowser will submit the response to comments as a separate document at a later date.

